The Canadian Entomologist

Vol. LXXXVIII Ottawa, Canada, April 1956 No. 4

New Species of Bark Beetles (Coleoptera: Scolytidae), Mostly Mexican. Part I[1]

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In this paper 13 new species and a new genus (*Phloeocleptus*) of scolytid beetles of the tribe Micracini are described from Mexico and Honduras. Unless stated otherwise, the specimens taken in Mexico were collected by the author while with the 1953 expedition of the Francis Huntington Snow Entomological Museum (University of Kansas, Lawrence). The new species represent the following genera: *Hylocurus* (6), *Phloeocleptus* (2), *Micracis* (4), and *Pseudothysanoes* (1).

Hylocurus nodulus, new species

This species is evidently more closely allied to *ruber* than to other known species. In both species each elytral interspace of the male is armed on the posterior third of the disc and upper part of the declivity by a row of large rounded nodules, some of them higher than wide; the discal striae are much narrower near the declivital base. This species differs from *ruber* in having the elytral striae not impressed, with the punctures very small and shallow; the posterior half of the pronotum granulate; the female frons convex, granulate, and subglabrous; and the body colour black. From *robustus* Schedl it differs by the higher, more numerous interstrial nodules extending to the upper parts of the declivity, and the much longer elytral vestiture.

Male.—Length 2.2 mm. (paratypes 1.8-2.4 mm.), 2. times as long as wide; body colour black.

Frons weakly convex, with an irregular transverse elevation at upper level of eyes, slightly impressed below elevation; surface granulate above, subreticulate below; vestiture hairlike, minute, and inconspicuous except longer on epistomal margin. Antennal club subcircular, the sutures bisinuate.

Pronotum slightly longer than wide; sides almost subparallel on basal half, converging toward the rather narrowly rounded anterior margin; anterior margin armed by two, close but basally separate, large teeth; posterior half punctured, sparsely and shallowly laterally, rather finely and sparsely granulate behind summit.

Elytra with sides subparallel on basal three-fourths, obtusely acuminate behind; striae feebly impressed, the punctures rather small, close, decreasing in size anteriorly on basal one-fourth; interstriae slightly wider than striae, indistinctly convex basally, the punctures about two-thirds as large as those of striae; posterior one-third of disc armed by about three to five large, rounded interstrial nodules, each nodule as wide and as high as the width of an interspace, the rows of nodules continuing to near middle of declivity except extending only to declivital margin on interspaces one and two; on declivity the nodules usually smaller and more slender; ninth declivital interspace rather broadly elevated, rather abruptly descending at its apex. Vestiture consisting of very long, coarse, interstrial bristles on declivity, and of fine hairlike strial setae about half as long

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as the bristles; bristles on anterior half of elytra largely abraided in type series, but not more than half as long as on declivity.

Female.—Similar to male except: anterior margin of pronotum unarmed; nodules of elytra arranged similarly, but much smaller; ninth interspaces less strongly elevated; and vestiture fine, hairlike. In general the entire body is more finely sculptured.

Type Locality.—Pujal, San Luis Potosi, Mexico.

Host.—Bamboo.

Type Material.—The male holotype, female allotype, and 26 paratypes were collected at the type locality on June 20, 1953, from a native bamboo tree. The galleries were constructed in material about four inches in diameter. The holotype, allotype, and some paratypes are in the Snow Entomological Collections; other paratypes are in the Canadian National Collection and the collections of the U.S. National Museum.

***Hylocurus ruber*, new species**

This species is allied to *nodulus* and *impar* Schedl, but is readily distinguished by the larger size; by the reddish-brown colour; by the punctured area behind the summit of the pronotum having only a few granules intermixed with the punctures; by the more coarsely striate elytra; and, in the female, by the planoconcave and pilose frons.

Male.—Length 2.80 mm. (paratypes 2.5-3.1 mm.), about 2.7 times as long as wide; body colour reddish-brown.

Frons evenly convex, except epistomal region flattened; surface rather sparsely and finely granulate; vestiture sparse, short, coarse. Eye about twice as long as wide; finely granulate. Antennal scape with a small tuft of rather long hair; club very slightly longer than wide, the sutures bisinuate.

Pronotum indistinctly longer than wide; sides subparallel on basal half; evenly, broadly rounded in front and armed by about 12 teeth; posterior half punctured, a few small granules intermixed with the punctures behind the summit; vestiture short, inconspicuous, almost scalelike.

Elytra with sides subparallel on basal three-fourths, acutely acuminate behind, the small notch produced by the apex of the elevation of the ninth interspace visible from above; striae distinctly impressed, the punctures rather coarse, deep, close; interstriae as wide as striae, the punctures fine and widely spaced; each interspace posteriorly armed on the disc by about two to four large, rounded, interstrial nodules, each nodule as wide as an interspace and the posterior ones as high as wide, the rows of nodules continuing to upper part of declivity; a few additional, more slender, toothlike nodules on declivital interspaces one, three, seven, and nine; ninth interspaces narrowly elevated, posteriorly terminating sharply, a single large nodule just behind apex of this elevation. Vestiture consisting of sparse, moderately long, scalelike interstrial bristles, one bristle arising from base of each nodule; and minute hairlike strial setae less than one-fourth as long as interstrial bristles.

Female.—Similar to male except: frons planoconcave and pilose on the median half, the pubescence dense and reddish-yellow; antennal scape with a larger tuft of hair; elytral sculpture finer, the nodules smaller, the ninth interspace but slightly elevated.

Type Locality.—Los Abritos (20 miles northeast of Ciudad del Mais), San Luis Potosi, Mexico.

Host.—Evidently *Robinia* sp.

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Type Material.—The male holotype, female allotype, and nine paratypes were collected at the type locality on June 18, 1953, from a broken stump about three inches in diameter of what appeared to be *Robinia* sp. The host grew in an association of sweet gum, hickory, and other elements typical of the deciduous forest of the southeastern United States. The holotype, allotype, and some paratypes are in the Snow Entomological Collection; other paratypes are in the Canadian National Collection and the collection of the U.S. National Museum.

Hylocurus effeminatus, new species

Fig. 4

In this species the secondary sexual characters usually found in representatives of the genus are almost non-existent. Evidently it is more closely allied to *nodulus* than to other known species, although both sexes closely resemble the female of the three following species. The virtual absence of sexual dimorphism, and the presence of rows of very small interstrial nodules near the declivital base distinguish it from other known species. It also differs from *nodulus* in having coarser striae, and the posterior and lateral areas of pronotum coarsely reticulate and with fine granules.

Male.—Length 2.1 mm. (paratypes 1.8-2.2 mm.), 2.5 times as long as wide; colour dark brownish-black.

Frons weakly convex; coarsely, closely punctured above; coarsely reticulate below the weak transverse, granulate elevation; vestiture minute, inconspicuous, longer on epistoma. Antennal club subcircular, the sutures bisinuate.

Pronotum slightly longer than wide; sides subparallel on basal half, rather broadly rounded anteriorly; anterior margin armed by about ten small serrations; posterior half rather sparsely, finely granulate, with a few shallow punctures intermixed; vestiture consisting of sparse short hairlike setae.

Elytra with sides subparallel on basal three-fourths; acutely acuminate behind; striae distinctly impressed, the punctures rather small, close, distinct; interstriae about as wide as striae, subcrenulate anteriorly, finely and sparsely punctured, becoming tuberculate posteriorly, the tubercles rather small, sharply pointed posteriorly. Declivity (Fig. 4) very steep; striae one and two distinct, others confused; interspace one finely, sparsely serrate to apex; interspace three slightly elevated and armed by two rather large teeth, and a slightly larger tooth at junction of interspaces three and seven; several small teeth around upper margin on all interspaces; ninth interspace rather sharply elevated, the elevation apically terminating abruptly. Vestiture consisting of minute hairlike setae, except at declivital margin where it consists of longer, rather broad scalelike bristles.

Female.—Similar to male except: frontal vestiture more abundant, longer, coarse, the transverse elevation obscure; anterior margin of pronotum unarmed; declivity not as steep; ninth declivital interspace less strongly elevated; and vestiture at base of declivity hairlike.

Type Locality.—Five miles northwest of Totolapan, Oaxaca, Mexico.

Host.—Unknown.

Type Material.—The male holotype, female allotype, and 11 paratypes were collected at the type locality on July 7, 1953, at an elevation of 3,300 feet. Five other paratypes were collected 16 miles west of Tehuantepec, Oaxaca, Mexico, on July 8, 1953. The holotype, allotype, and some paratypes are in the Snow Entomological Collections; other paratypes are in the Canadian National Collection and the collections of the U.S. National Museum.

Hylocurus medius, new species

Fig. 2

This species is somewhat intermediate between *effeminatus* and *parkinsonae* Blackman. The declivital margin of the male is weakly angulate, and the circumdeclivital ring of interstrial tubercles is less strongly elevated than in *parkinsonae*, but is more strongly elevated than in *effeminatus;* the female frons is more strongly impressed and has more abundant pubescence than either of the allied species.

Male.—Length 2.2 mm. (paratypes 2.0-2.4 mm.), 2.6 times as long as wide; body colour piceous.

Frons convex and rather coarsely granulate-punctate above, transversely impressed and coarsely reticulate above epistoma; vestiture consisting of sparse, short, rather coarse setae, becoming longer near epistoma. Antennal club subcircular, the sutures bisinuate (antennae missing, and upper part of frons obscured on type; these parts described from paratypes).

Pronotum slightly longer than wide; sides subparallel on basal half; rather broadly rounded in front and armed by about ten small serrations; posterior area granulate, with a few punctures intermixed laterally, the granules rather coarse behind the summit; vestiture inconspicuous, short, hairlike.

Elytra with sides subparallel on basal three-fourths, acutely acuminate behind; striae distinctly impressed, the punctures small, close, rather deep; interstriae convex, wider than striae, the punctures very widely spaced, shallow, half as large as the strial punctures; a rather large tubercle at upper margin of declivity on each interspace forming part of the circumdeclivital ring (Fig. 2), each tubercle much narrower than the interspace and not higher than wide. Declivity moderately steep, convex; all striae distinct to their apices; interspace one sparsely tuberculate to apex; one, three, five, and seven each with one submarginal tubercle (as many as three may occur on each of these interspaces in paratypes, as in Fig. 2); three with two larger tubercles, the second of these at or near junction of interspaces three and seven; nine rather strongly, narrowly elevated, the elevation terminating abruptly at its apex. Vestiture hairlike, coarse on declivital margin.

Female.—Similar to male except: frons planoconcave on median third, the impression rather densely covered by moderately long coarse yellow hair; anterior margin of pronotum unarmed; the circumdeclivital ring of tubercles absent, the submarginal tubercles and those on declivital face present as in the male; and the ninth declivital interspace less strongly elevated.

Type Locality.—Five miles west of Antiguo Morelos, Tamaulipas, Mexico.

Host.—Unknown.

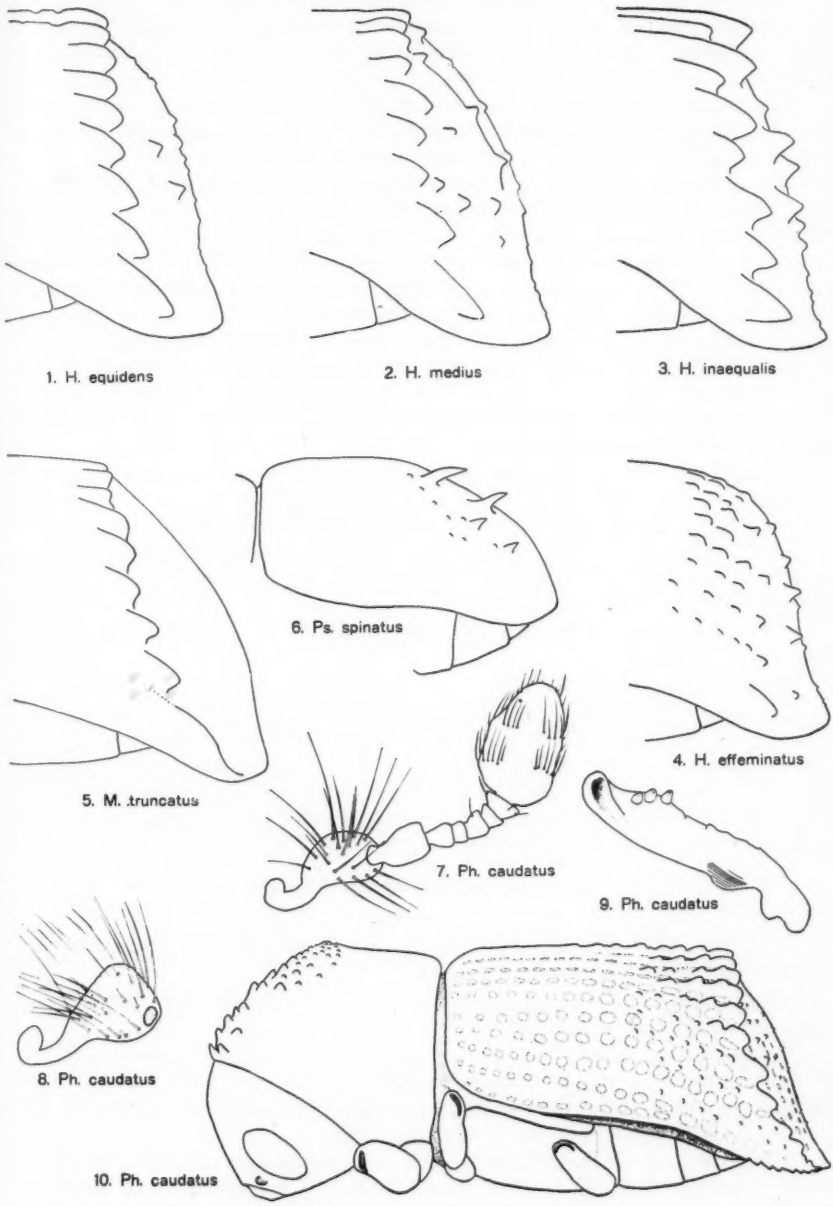
Type Material.—The male holotype, female allotype, and 25 paratypes were collected at the type locality on June 20, 1953; one other paratype was collected at Pujal, San Luis Potosi, Mexico, on June 20, 1953. The holotype, allotype, and some paratypes are in the Snow Entomological Collections; other paratypes are in the Canadian National Collection and the collections of the U.S. National Museum.

Hylocurus equidens, new species

Fig. 1

This species evidently is closely allied to *retusipennis* Blandford, but differs by the absence of punctures on the posterior half of the pronotum.

Male.—Length 2.1 mm. (paratypes 1.8-2.4 mm.), 2.5 times as long as wide; body colour black.



Figs. 1-6. Lateral aspect of male elytral declivity: 1, *Hylocurus equidens*; 2, *H. medius*; 3, *H. inaequalis*; 4, *H. effeminatus*; 5, *Micracis truncatus*; and 6, *Pseudothysanoes spinatus*.

Figs. 7-10. *Phloeocleptus caudatus*: 7, antenna of male; 8, antennal scape of female; 9, anterior tibia of female; and 10, lateral aspect of male.

Frons flattened on median half, with an obscure transverse elevation just below upper level of eyes; vestiture rather short, moderately abundant, rather coarse, hairlike. Antennal club indistinctly longer than wide, the sutures bisinuate.

Pronotum slightly longer than wide; sides subparallel on basal half, rather broadly rounded in front; anterior margin armed by about twelve small serrations; posterior half with sparse, fine granules; vestiture minute, hairlike.

Elytra with sides subparallel on basal three-fourths, acutely acuminate behind; striae distinctly impressed, the punctures of moderate size, close, rather deep; interstriae about as wide as striae, convex, the punctures sparse, about one-third as large as those of striae; interspaces produced behind to form a circumdeclivital ring of rather large blunt tubercles of equal size (Fig. 1). Declivity very steep, subvertical, convex; interspace one finely serrate; three with two (on right, three on left elytron of type) teeth on third interspace; nine sharply, narrowly elevated, the elevation terminating abruptly behind; all striae distinct to their apices, the punctures large near upper margin and decreasing in size apically. Vestiture fine, short, and hairlike on disc; short and very coarse around declivital margin and near teeth of third interspace.

Female.—Similar to male except: frons more finely, deeply punctured over a larger area, the transversely raised area absent; anterior margin of pronotum unarmed; circumdeclivital ring of tubercles replaced by a series of two or three very small tubercles on each interspace at declivital margin; declivital face more strongly convex; ninth interspace less strongly elevated; and pubescence on declivity longer, more abundant, hairlike.

Type locality.—Los Abritos (20 miles northeast of Ciudad del Mais), San Luis Potosi, Mexico.

Host.—Evidently *Robinia* sp.

Type material.—The male holotype, female allotype, and 21 paratypes were collected at the type locality on June 18, 1953, from the same piece of wood that contained the type series of *ruber*. The host appeared to be a species of *Robinia*. The holotype, allotype, and some paratypes are in the Snow Entomological Collections; other paratypes are in the Canadian National Collection and the collections of the U.S. National Museum.

***Hylocurus inaequalis*, new species**

Fig. 3

This species evidently is allied to *spinifex* Blandford, but differs conspicuously in the declivital armature (Fig. 3).

Male.—Length 2.2 mm. (paratypes 1.8-2.4 mm.), 2.6 times as long as wide; body colour dark brownish-black.

Frons weakly convex, rather coarsely, closely punctured above and very finely sculptured below the transverse, granulate elevation located at the upper level of the eyes; vestiture consisting of rather sparse, short, rather coarse hair. Antennal club subcircular, the sutures bisinuate.

Pronotum slightly longer than wide; sides subparallel on basal half, rather broadly rounded in front; anterior margin armed by ten rather coarse serrations; posterior half rather finely, shallowly, subgranulately punctured; vestiture minute, hairlike.

Elytra with sides subparallel to declivital base; truncate behind, with the posterior profile interrupted by the acute terminal mucro, the declivital teeth, and the elevations of the ninth interspaces; striae impressed, deeply near the declivity, the punctures small, deep, close; interspaces convex, wider than striae,

the punctures rather sparse and about half as large as those of striae; interspaces produced behind to form a circumdeclivital ring of large stout pointed tubercles (Fig. 3), those on interspaces one, three, five, seven, eight, and nine conspicuously longer than others. Declivity almost verticle, convex; interspace one finely serrate, three with two (on left, three on right elytron of type) teeth; lateral areas very coarsely punctured. Vestiture fine, hairlike on disc; short and stout on declivity, squamose around declivital margin.

Female.—Similar to male except: frons flattened, more finely punctured; armature on anterior margin of pronotum finer, not visible from above; the circumdeclivital tubercles absent except for minute interstrial tubercles; tubercles on face of declivity similar to male, the lateral punctures smaller; and ninth declivital interspace rather weakly elevated.

Type locality.—Six miles south of Tehuantepec, Oaxaca, Mexico.

Host.—Probably *Acacia* sp.

Type material.—The male holotype, female allotype, and 37 paratypes were collected at the type locality on July 8, 1953, from a thorn tree about 15 feet in height, presumably a species of *Acacia*. The holotype, allotype and some paratypes are in the Snow Entomological Collections; other paratypes are in the Canadian National Collection and the collections of the U.S. National Museum.

Phloeocleptus, new genus

This genus, at least superficially, is very similar to *Hylocurus*, but evidently is more closely related to *Thysanoes* and *Stenoclyptus*. The elytral apex is acuminate as in *Hylocurus*; the asperities of the pronotum are confined to a rather definite area, and the summit is rather well defined as in *Thysanoes;* and the anterior tibiae resemble those of *Stenoclyptus*. Sexual dimorphism in one of the two species at hand (Fig. 10) is quite similar to extreme examples of *Hylocurus*, but has developed along an entirely different phyletic line; sexual differences in the other species are not readily apparent. The parallel development of the *Hylocurus* type of sexual dimorphism is also made known in species of *Micracis* and *Pseudothysanoes* described in this paper.

Both species of this new genus breed in the bark of twigs or small branches. The two egg tunnels in each system of galleries were almost entirely in the bark, parallel to the grain of the wood, and filled with boring dust except near the end where the female was working; the male remained in the nuptial chamber.

Description.—Body form small, cylindrical; frons convex, with the vestiture inconspicuous; eye short, oval, entire; antennal scape short (Figs. 7-8), appearing subtriangular in both sexes and usually bearing several long hairs, the funicle six-segmented, the club rather slender and with two straight or very weakly procurved sutures indicated only at the sides by setae; pronotum about as wide as long, summit at middle, asperities rather coarse, sparse, confined to an oval area on anterior three-fifths; elytra strongly acuminate behind, the sculpture may exhibit secondary sexual differences; anterior coxae separated; fore tibiae (Fig. 9) slightly widened distally, with two or three submarginal teeth, not tuberculate or coarsely rugose on posterior face; third tarsal segments slender.

Type Species.—*Phloeocleptus caudatus*, new species; described below.

Phloeocleptus caudatus, new species

Figs. 7-10

This species is but remotely related to *obscurus*; it differs by the larger size, coarser sculpture, and conspicuous sexual dimorphism. The male (Fig. 10) is superficially similar to the male of some *Hylocurus* species, ie. *cancellatus* Blandford and *equidens*.

Male.—Length 1.6 mm. (paratypes 1.5-1.7 mm.), 2.5 times as long as wide; body colour black.

Frons flattened on a narrow median area below, convex above; smooth and finely punctured on the flattened area, coarsely reticulate and finely, sparsely granulate at sides and above; vestiture evident only near epistoma. Eye about twice as long as wide, entire; finely granulate. Antennal club (Fig. 7) about 1.5 times as long as wide, the sides constricted at the two straight, non-septate sutures; the sutures indicated only at sides by rows of setae, the setae on the central third of each suture obsolete.

Pronotum about as wide as long; sides weakly arcuate, feebly constricted just in front of middle, rather narrowly rounded in front; anterior margin armed by four rather closely spaced teeth; summit at middle; asperities rather large, isolated, confined to an oval area between summit and anterior margin; posterior and lateral areas finely reticulate, minutely and sparsely punctured laterally, finely and sparsely granulate behind the summit.

Elytra with sides straight and diverging slightly toward declivital base; obtusely acuminate behind; striae impressed only near declivity, the punctures coarse, close, deep, increasing in diameter posteriorly; interstriae granulate anteriorly, becoming uniseriately tuberculate on posterior half of disc, about as wide as striae at base, less than half as wide as striae near declivity; each interspace armed at declivital margin by a large, blunt tubercle, these tubercles of equal length and forming a circumdeclivital ring of tubercles that continues along the elevated ninth interspace to the elytral apex; tubercles on elevated part of ninth interspace smaller than the others and decreasing in size posteriorly. Declivity steep, convex, margined by the well developed circumdeclivital elevated ring of tubercles; striae distinct to their apices; interspace one finely serrate to apex; two and three serrate on upper two-thirds, the teeth slightly longer on three and less abundant (about five). Vestiture hairlike, the strial setae indistinctly smaller than those of the interstriae; about twice as long on the declivity as on the disc.

Female.—Similar to male except: process of antennal scape (Fig. 8) more strongly produced, the pubescence longer and more abundant; anterior margin of pronotum unarmed; strial punctures indistinctly larger posteriorly; interstriae slightly narrower than striae, uniseriately granulate; the circumdeclivital ring of tubercles absent; declivity less abrupt, the ninth interspace more finely tuberculate to apex, narrowly but less strongly elevated.

Type Locality.—Five miles northeast of Teziutlan, Puebla, Mexico.

Host.—Unknown.

Type Material.—The male holotype, female allotype, and 17 paratypes were collected at the type locality on June 27, 1953, at an elevation of 4800 feet. The beetles were breeding in the bark of a small broken branch of a roadside tree that superficially resembled magnolia. The holotype, allotype, and some paratypes are in the Snow Entomological Collections; other paratypes are in the Canadian National Collection and the collections of the U.S. National Museum.

Phloeocleptus obscurus, new species

This species is congeneric with *caudatus*, but only remotely related. It is distinguished by its smaller size, less obvious secondary sexual characters, and finer sculpture.

Male.—Length 1.1 mm. (paratypes 1.1-1.2 mm.), 2.5 times as long as wide; body colour very dark brown.

Frons broad, weakly convex, finely, sparsely punctured; vestiture minute, sparse, obscure except along epistoma. Antennal scape short, subtriangular,

ornamented by a few long hairs; club about 1.5 times as long as wide, constricted at sutures; sutures evidently straight, indicated only at sides by rows of setae.

Pronotum about equal in width and length; sides weakly arcuate, converging and rather narrowly rounded anteriorly; anterior margin armed by two rather widely separated teeth; summit at middle; asperities limited to an oval area between summit and anterior margin, rather coarse; posterior area smooth laterally with a few fine punctures, reticulate and sparsely granulate behind summit; vestiture hairlike, rather long.

Elytra with sides straight and diverging slightly toward declivity; strongly acuminate behind; striae indistinctly impressed, the punctures fine, close, rather deep, slightly wider toward declivity; interstriae feebly convex, indistinctly narrower than striae, minutely uniseriately granulate. Declivity steep, not abrupt; striae obscure, the punctures small; interspace one finely serrate to apex; three, five, seven, eight, and nine very finely serrate on upper half, nine rather weakly and broadly elevated posteriorly but the elevation expiring before reaching the finely serrate costal margin. Vestiture consisting of minute strial hair, and rather long flattened interstrial bristles; slightly longer on the declivity.

Female.—Similar to male except: antennal scape more broadly triangular, the pubescence longer and more abundant; anterior margin of pronotum unarmed; and serrations of declivity and elevation of ninth interspace indistinctly smaller.

Type Locality.—El Salto, San Luis Potosi, Mexico.

Host.—Persea americana.

Type Material.—The male holotype, female allotype, and 17 paratypes were collected at the type locality on June 19, 1953, from the bark of Avocado twigs. The holotype, allotype, and some paratypes are in the Snow Entomological Collections; other paratypes are in the Canadian National Collection and the collections of the U.S. National Museum.

***Micracis photophilus*, new species**

Fig. 15

This species evidently is more closely allied to *cubensis* Blackman than to other representatives of the genus, but differs by the antennal characters, by the fine, shallow strial punctures, and by having all declivital interspaces finely granulate.

Female.—Length 1.9 mm., 2.6 times as long as wide; body colour reddish-brown.

Frons convex and granulate-punctate above; flattened, with a slight median impression, and coarsely reticulate below; the median epistomal area smooth and shining; vestiture at sides and above rather short and coarse, minute or absent below. Eyes coarsely granulate. Antennal scape (Fig. 15) short, triangularly dilated distally, ornamented by a few rather long hairs; club about one and one-half times as long as wide, the first suture extending less than half the length of the club, the sutures narrowly procurved (sutures of the type are somewhat more strongly, narrowly procurved than in the paratype illustrated in Fig. 15).

Pronotum indistinctly longer than wide; widest near middle, the sides almost straight on the posterior half, rather broadly rounded in front; anterior margin armed by four teeth; posterior half reticulate and sparsely, very finely punctured; vestiture short, hairlike, semirecumbent.

Elytra with sides straight and subparallel on basal three-fourths, obtusely acuminate behind; striae not impressed, the punctures very fine, shallow, rather obscure; interstriae flat, about three times as wide as striae, the punctures minute, obscure. Declivity rather steep, convex; striae obscure, the punctures small; interstriae one to nine dull, rather sparsely, uniseriately granulate; nine weakly

elevated. Vestiture short on disc, longer on declivity; consisting of minute strial hair, and rather long, coarse, pointed, interstrial bristles; an additional row of short, coarse bristles along declivital suture.

Male.—Similar to female except: antennal scape more narrowly, subcircularly dilated distally. Sculpture of frons, pronotum and elytra as in female.

Type Locality.—El Salto, San Luis Potosi, Mexico.

Host.—Unknown.

Type Material.—The female holotype and male allotype were collected at the type locality on June 19, 1953 at light. One female paratype was collected at Olanchito, Honduras, on Sept. 8, 1949, at light, by E. C. Becker. The holotype and allotype are in the Snow Entomological Collections; the paratype is in the Canadian National Collection.

Micracis ovatus, new species

Figs. 13-14

This species is easily distinguished from other known representatives of the genus by the following combination of characters: declivital vestiture of both sexes scalelike; antennal scape subquadrate (Fig. 14); first suture of the antennal club broadly rounded, extending about one-third the length of the club; female with a sharply defined, shining, ovate frontal elevation (Fig. 13); and body form of the female unusually slender.

Female.—Length 2.7 mm. (paratypes 2.4-2.8 mm.), 3.7 times as long as wide; body colour dark reddish-brown.

Frons weakly convex, with a sharply defined, smooth, shining, ovate, median elevation (Fig. 13) extending from epistomal margin about two-thirds the distance to upper level of eyes; lateral and dorsal areas finely granulate; vestiture short, sparse, hairlike. Antennal scape subquadrate, marginally ornamented by numerous very long hairs (Fig. 14); club one and one-half times as long as wide, oval, the first suture extending one-third the length, the second suture extending more than three-fourths the length of the club.

Pronotum 1.34 times as long as wide; sides straight and subparallel on more than the basal half, rather broadly rounded in front; posterior half finely reticulate, shining, with sparse minute punctures; vestiture minute, hairlike.

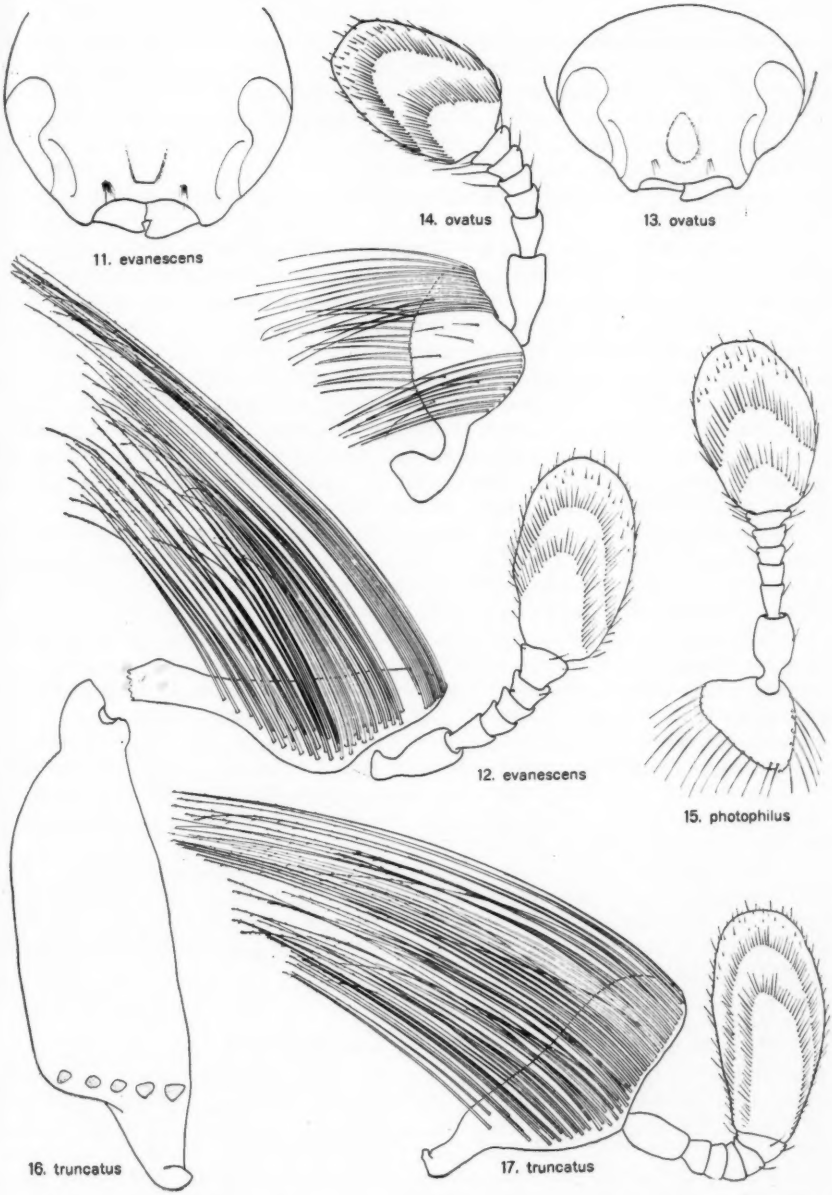
Elytra 2.4 times as long as wide; about 2.15 times as long as pronotum; sides straight and subparallel on basal three-fourths, acutely acuminate behind; striae not impressed, the punctures rather large, shallow; interstriae feebly convex, about as wide as striae, the punctures obscure. Declivity not steep, convex; each interspace uniseriately armed by small rounded granules; ninth interspace weakly elevated. Vestiture consisting of minute strial hair, and longer, narrow, erect interstrial scales; an additional row of shorter scales present at declivital suture; vestiture usually abraded on disc.

Male.—Similar to female except: length 2.1 mm. (1.9-2.2 mm.), 3.3 times as long as wide; frontal elevation poorly developed, not clearly defined; antennal scape about two-thirds as large, the hair shorter; anterior margin of pronotum armed by eight slender teeth; scales on pronotum and elytra stouter.

Type Locality.—Five miles northeast of Teziutlan, Puebla, Mexico.

Host.—Unknown.

Type Material.—The female holotype, male allotype, and 37 paratypes were collected at the type locality on June 27, 1953, from young recently cut trees about two inches in diameter. The holotype, allotype and some paratypes are in the Snow Entomological Collections; other paratypes are in the Canadian National Collection and the collections of the U.S. National Museum.



Figs. 11-17. *Micracis* spp.: 11, *evanescens*, cephalic aspect of head of female; 12, *evasescens*, antenna of female; 13, *ovatus*, cephalic aspect of head of female; 14, *ovatus*, antenna of female; 15, *photophilus*, antenna of female; 16, *truncatus*, fore tibia of female; and 17, *truncatus*, antenna of female.

***Micracis evanescens*, new species**

Figs. 11-12

This species evidently is more closely allied to *ovatus* than to other known forms, but is readily distinguished by the following characters: frontal elevation of the female larger and not sharply defined above (Fig. 11); antennal scape narrowly triangular (Fig. 12); first suture of the club very narrowly rounded, extending half the length of the club; vestiture on the posterior half of the pronotum scalelike; and body form stouter.

Female.–Length 2.7 mm. (paratypes 2.5-2.8 mm.), 3.0 times as long as wide; body colour reddish-brown.

Frons weakly convex, with a prominent flat, smooth, shining, glabrous elevated median area extending from just above epistomal margin almost to upper level of eyes, its width (above) almost equal to half the distance between eyes (Fig. 11); the elevation subtrapezoidal with the sides diverging dorsally, sharply defined on lower half, and evanescent above but more or less arcuately delimited by coarser sculpture and by setae; coarsely reticulate and punctate at the sides and above; vestiture rather short and coarse, longer and directed dorsally above. Antennal scape (Fig. 12) narrowly triangular, sublinear, ornamented by numerous very long hairs; club about one and one-half times as long as wide, the first suture narrowly procurved and extending half the length of the club, the second extending three-fourths the length of the club.

Pronotum about 1.1 times as long as wide; sides straight and subparallel on basal half, rather broadly rounded in front; posterior half coarsely reticulate and with a few minute granules; vestiture sparse, short, semirecumbent, consisting of equal numbers of hairlike and scalelike setae.

Elytra twice as long as wide; sides straight and subparallel on basal three-fourths; obtusely acuminate behind; striae not impressed, the punctures of moderate size, distinct, shallow; interstriae almost flat, as wide as striae, minutely crenulate, the punctures obscure. Declivity rather steep, convex; interstriae coarsely reticulate, uniseriately and finely tuberculate to apex, the tubercles on striae one and two smaller; ninth interspace weakly elevated. Vestiture consisting of minute strial hair, and rather long erect scales; an additional row of short scales along each side of the suture of the declivity; vestiture usually abraded on disc, somewhat longer on declivity.

Male.–Similar to female except: frontal elevation absent except for a very small shining, raised median area above epistoma, an indistinct median impression above this elevation; antennal scape triangular, not extended beyond insertion of funicle; anterior margin of pronotum armed by ten teeth; and declivital scales slightly longer and wider.

Type Locality.–Thirty miles southwest of El Salto, Durango, Mexico.

Host.–*Quercus* sp.

Type Material.–The female holotype, male allotype, and four paratypes were collected at the type locality on July 23, 1953, from a narrow-leaved oak. Nine other paratypes were collected from oak in Mexico as follows: 35 miles southwest of El Salto, Durango, on July 23, 1953; and 20 miles northeast of Copala, Sinaloa, on July 22, 1953. The holotype, allotype, and some paratypes are in the Snow Entomological Collections; other paratypes are in the Canadian National Collection and the collections of the U.S. National Museum.

***Micracis truncatus*, new species**

Figs. 5, 16-17

This species exhibits a type of sexual dimorphism on the elytral declivity similar to that of *dimorphus* Schedl and resembling that of certain species of

Hylocurus. It appears to be more closely allied to *evanescens* than to previously described North American species, but differs by the following combination of characters: frontal elevation of the female absent; antennal club more slender; a circumdeclivital ring of tubercles present in the male; and body colour much darker. Superficially it resembles *dimorphus*, but may be only remotely related; the fore tibiae of *dimorphus* are narrow with the anterior face tuberculate as in species of *Hylocurus*, in *truncatus* they are broad (Fig. 16) with the anterior face smooth.

Female.—Length 2.9 mm. (paratypes 2.7-3.3 mm.), 3.4 times as long as wide; body colour very dark brown.

Frons convex, glabrous and impunctate on an area extending from the epistoma about two-thirds of the distance to upper level of eyes and occupying about half the distance between the eyes, this area finely reticulate except on a small shining epistomal area; vestiture short lateral to glabrous area, longer and directed dorsally above. Antennal scape (Fig. 17) rather narrowly triangular, funicle attached near middle, marginally ornamented by numerous very long hairs; club slender, twice as long as wide, the first suture rather narrowly procurved and extending more than half (0.6) the length of the club, the second suture extending more than three-fourths the length of the club.

Pronotum 1.25 times as long as wide; sides almost straight and subparallel on basal two-thirds; rather broadly rounded in front; posterior half coarsely reticulate and sparsely, minutely punctured; vestiture consisting of minute recumbent hair, and short broad erect white scales. Anterior tibiae (Fig. 16) broad.

Elytra about 2.2 times as long as wide; about 1.8 times as long as pronotum; sides straight and subparallel on basal three-fourths, obtusely acuminate behind; striae not impressed, the punctures rather small, distinct, shallow; interstriae feebly convex, wider than striae, the punctures about half as large as those of striae, shallow, obscure. Declivity rather steep, convex; striae weakly impressed, the punctures fine; interstriae with punctures confused, deep, almost as large as those of striae. Vestiture consisting of minute strial hair and longer erect, rather broad scales; declivital suture with a row of shorter, broad scales on each side; shorter and usually abraded on disc.

Male.—Similar to female except: length 2.6 mm., 3.0 times as long as wide; obliquely truncate behind; frons granulate above, the vestiture reduced; antennal scape triangular, not produced beyond the attachment of the funicle; teeth on anterior margin of pronotum larger, eight in number; each interspace armed at declivital margin by a rather large tubercle (Fig. 5), these form a circumdeclivital ring of tubercles similar to those of male *Phloeocleptus caudatus* and certain species of *Hylocurus*; the tubercles increase progressively in size from interspace one to eight, the elevation of interspace nine higher and continuing to elytral apex; declivital face less strongly convex, punctured similar to that of female; declivital setae wider.

Type Locality.—Eleven miles northeast of Jacala, Hidalgo, Mexico.

Host.—*Quercus* sp.

Type Material.—The female holotype, male allotype, and 22 paratypes were collected at the type locality on June 22, 1953, from a broken oak branch about two inches in diameter; four other paratypes were collected 32 miles southeast of Nochixtlan, Oaxaca, Mexico, on July 5, 1953 from an oak branch. Galleries were constructed in the wood similar to those of other species of the genus. The holotype, allotype and some paratypes are in the Snow Entomological Collections; other paratypes are in the Canadian National Collection and the collections of the U.S. National Museum.

***Pseudothysanoes spinatus*, new species**

Fig. 6

This unique species has the bifurcate terminal mucro on the anterior tibiae as in *Pseudothysanoes*; however, sutures on the antennal club are entirely absent in the male and very obscurely indicated in the female. The unusual armature of the male declivity (Fig. 6) and characters of the tibiae and antennae suggest a divergence from *Pseudothysanoes* of sufficient magnitude to characterize a new genus. However, until more is known of *Pseudothysanoes* and *Cryptocleptes* this species should remain in the genus *Pseudothysanoes*.

Male.—Length 1.25 mm., 2.5 times as long as wide; body colour yellowish-brown.

Frons transversely flattened on lower half, convex above; surface finely granulate; vestiture consisting of short, rather sparse, coarse hair. Eye short, oval; finely granulate. Antennal scape rather long, club-shaped; funicle six-segmented; club longer than wide, the sutures obsolete.

Pronotum 0.92 times as long as wide; sides weakly arcuate and converging toward the rather narrowly rounded anterior margin; anterior margin armed by five (normally six) rather large teeth; posterior half almost smooth and shining, with a few scattered, very fine punctures; vestiture consisting of rather short hair and scales, longer near summit.

Elytra 1.6 times as long as wide; sides straight and subparallel on basal two-thirds, rather broadly rounded behind; striae not impressed, the punctures rather large and deep; interstriae almost as wide as striae, the punctures finely granulate becoming rather coarse behind and ending at declivital margin. Declivity (Fig. 6) beginning at middle of elytra, gradual; striae indistinctly narrower than on disc, interstrial punctures with fine granules; second interspace armed on upper half by two very large, slender, sharply pointed spines separated from upper margin of declivity and from each other by a space equal to the length of one spine; interspace five armed by two similarly spaced but slightly smaller spines, the first on a level with the second spine of interspace two. Vestiture consisting of small recumbent strial hair, and slightly longer erect interstrial scales, the scales very broad, posteriorly becoming longer lateral to interspace five, smaller and narrow on median area of declivity.

Female.—Similar to male except: length 1.4 mm., about 2.7 times as long as wide; antennal club larger, sutures feebly indicated; pronotum unarmed on anterior margin; elytra more regularly striate, interstrial granules finer; declivity short, steep, convex, spines absent, granules reduced; and scales rather narrow, not conspicuously longer laterally on declivity.

Type Locality.—Sixteen miles west of Tehuantepec, Oaxaca, Mexico.

Host.—Unknown.

Type Material.—The male holotype, female allotype, and four paratypes were collected at the type locality on July 8, 1953, from a dead, rather dry branch of a tree resembling *Celtis*. The galleries were in the wood, and were similar to those of *Thysanoes*. The holotype and allotype are in the Snow Entomological Collections; the paratypes are in the Canadian National Collection and the collections of the U.S. National Museum.

The Bionomics of the Aspen Blotch Miner, *Lithocolletis salicifoliella* Cham. (Lepidoptera: Gracillariidae)[1]

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Introduction

The aspen blotch miner, *Lithocolletis salicifoliella*, Cham., has been abundant on trembling aspen, *Populus tremuloides* Michx., throughout central Canada for the past few years. The mines of this species are found on the underside of the leaves, and are often abundant enough to cause premature browning of the foliage. This insect first came to the attention of the Forest Insect Survey of Ontario in the vicinity of Lake Nipigon in 1944. By 1950, the infestation covered all but the southern part of Ontario, and was reported in most aspen stands in Manitoba and Saskatchewan. The intensity of the infestation in the northern part of Ontario began to decline by 1952, and in 1954 damage was negligible.

An investigation of the biology of this insect was begun in 1954 and was continued through the spring of 1955. This paper describes the life history and some of the habits of the insect. Information has been derived from both field observations and an analysis of data accumulated in the files of the Forest Insect Survey of Ontario since 1944.

Systematic Position, Distribution, and Hosts

The few published records referring to *L. salicifoliella* are very brief. Clemens (1861) described the mines, and although he did not see any adults, named the species *Lithocolletis salicifoliella*. Chambers (1875) described the adults and retained the name given by Clemens. Zeller (1875) also described this insect and gave it the name *L. atomariella*, Braun (1908), however, in revising the genus, decided that *L. atomariella* and *L. salicifoliella* were synonymous and gave preference to the latter name.

Chambers (1875) reports the presence of this species in Colorado at an elevation of more than 10,000 feet and in Kentucky at an elevation of 700 feet. Dyar (1902) lists its distribution as the Atlantic States and Braun (1908) states that it is probably found all over the United States. If, as is often the case, the distribution of the insect is correlated with that of its food plants, it is probably found over the whole of temperate North America.

Chambers (1875) bred this insect from willows and poplars, while Walsingham (1889) lists *Salix alba* L., *S. babylonica* L., *S. interior* Rowlee, *Populus tremuloides*, and *P. grandidentata* Michx. as hosts. Braun (1908) reared a number of specimens from mines in *Populus balsamifera* L. The records of the Forest Insect Survey of Ontario for the period 1951 to 1954 reveal that 847 collections were received, the host distribution being as follows:

Host	No. of collections
Populus tremuloides	833
Populus grandidentata	8
Populus balsamifera	4
Salix sp.	2

In 1954 and 1955, the foliage of *P. grandidentata* did not appear until the flight period of this insect was practically finished, and this is probably the reason that this tree is not a more important host. The foliage of *P. balsamifera* and the willows, however, developed at about the same time as that of *P. tremuloides*, and this suggests that the last species is the preferred host, in this region at least.

[1]Contribution No. 272, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.

Methods of Study

The investigation was conducted in the immediate vicinity of Sault Ste. Marie, Ontario. The infestation in this area had declined to such an extent by 1954 that it was impossible to find large stands supporting a heavy infestation of the miners. Small clones of trees, however, showed medium-to-heavy damage, and these trees were utilized to study the insect-host relationships.

It was found impossible to rear these insects satisfactorily under laboratory conditions, and the life history was therefore determined entirely from observations of field material. Large lots of leaves were collected twice weekly, and the mines were dissected to follow the activity and development of the insect from egg to adult. Since the head capsules and cast skins remain within the mines, it was a simple matter to determine the various instars. A number of leaves, bearing mines of the various instars, were preserved, embedded, and sectioned to determine which plant tissues were consumed during each period. A large series of adults and their parasites were reared from pupae removed from the mines. The pupae were placed in shell vials and the vials were inserted into holes in a plaster of Paris block, according to the method outlined by Peterson (1944).

Methods employed in the study of different features of the habits of the insect will be described in appropriate later sections.

Life History

The aspen blotch miner has one generation per year, with the stages distributed as shown in Fig. 1. The overwintering adult deposits its eggs on the underside of the leaves from the middle of May to the middle of June. There are five larval instars, pupation takes place in the mine, and the adults emerge in late summer.

Egg

The eggs are about 0.4 mm. in diameter, hemispherical, and laid with the flat surface against the leaf. They are shining and transparent, and look very much like tiny water droplets on the underside of the leaves. They hatch in approximately 15 days.

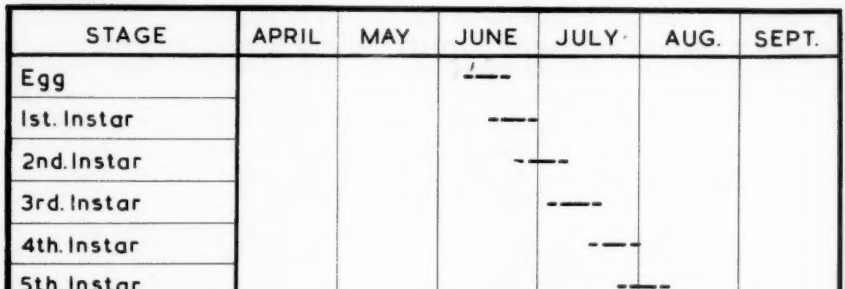

Fig. 1–Distribution of the stages in the life history of *Lithocolletis salicifoliella* throughout the year.

TABLE I

Relationship between the number of eggs per leaf and the place of oviposition

No. of eggs per leaf	No. of leaves	No. of leaves with all eggs marginal	No. of leaves with eggs scattered	Percentage of leaves with all eggs marginal
1	40	37	3	93
2	39	30	9	77
3	46	25	21	56
4	35	14	21	40
5	30	0	30	0
6	33	0	33	0
7	39	0	39	0
8	25	0	25	0

The position of the egg on the leaf is quite typical for some of the leaf mining insects and can sometimes be used to assist in determining the species (Needham, Frost and Tothill, 1928). Table 1 shows that there is a tendency for this species to place its eggs on the leaf margins, when there are not more than three eggs per leaf. In heavier infestations, however, the eggs are scattered at random. It is clear that even in light infestations, there is not sufficient constancy in this factor to make it of any value in determining species.

First-instar Larva

The larva, upon hatching, eats its way through the lower epidermis directly into the spongy parenchyma. Entry into the leaf is through the flattened side of the egg so that there is no opening from the mine to the outside, other than the natural ones provided by the stomata. The mode of entry is shown in Fig. 2A. There is no epidermal mining stage in this species. As soon as the anterior portion of the body enters the parenchyma, the larva feeds with its head moving from side to side, and a wedge-shaped mine results. With the ever widening swings of the body, the mine gradually assumes a circular shape. The first-instar mine reaches a diameter of about 3 mm.

The mouthparts are directed forwards and the larva is able to feed in a horizontal plane only. Feeding is restricted entirely to the spongy parenchyma, but the lowest layer of these cells is left untouched, so that the lower wall of the mine is made up of a single layer of spongy parenchyma and the epidermis. This is not shown in Fig. 2A but is well illustrated in Fig. 2B. During feeding, the mandibles move to and fro in a horizontal manner. The larva lies in an inverted position in the mine throughout its lifetime.

The body of the larva is flattened and quite transparent, and it moults by shedding the head-capsule anteriorly and the remainder of the exoskeleton posteriorly. The frass is black, of solid consistency, elliptical, and pointed at both ends. It is deposited in one spot, usually at or near the centre of the mines, and is attached to the upper surface.

Second-instar Larva

The second-instar larva continues feeding in the same manner as the first. It moves in a circle around the margin of the mine and feeding is again restricted to the spongy parenchyma. The mine remains nearly circular unless the larger veins are encountered. The smaller veins do not affect the shape of the mine, although they are never eaten; the larva feeds on the tissue beneath the vascular bundles, leaving the bundles themselves untouched. This is true for all five instars. The second-instar mine reaches a diameter of about 6 mm.

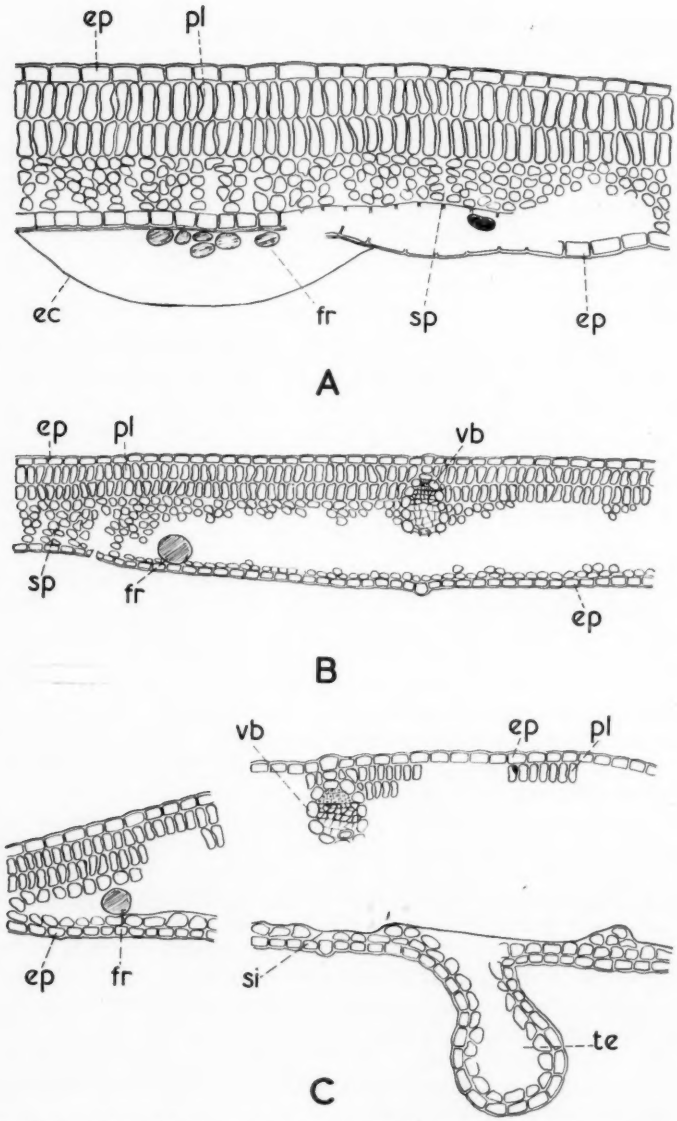

Fig. 2—Vertical sections of leaves of *Populus tremuloides* showing the mines of *Lithocolletis salicifoliella*.

A. Early first-instar mine.
B. Central portion and margin of third-instar mine.
C. Central portion and margin of fifth-instar mine.

ec—egg case, ep—epidermis, fr—frass, pl—palisade layer, si—silk, sp—spongy parenchyma, te—tentiform fold, vb—vascular bundle.

The larva is still flattened and transparent, and moults in the same manner as the first instar. The frass differs from that of the first instar in being larger and globular but it is still smooth and glossy black and of solid consistency. It is dropped at random in the mine, but is later moved to the pile begun by the first-instar larva.

Third-instar Larva

The third-instar larva does not show any change in method of feeding from that of the first and second instars, with activity still restricted to the spongy parenchyma. The mine at this stage (Fig. 2B) usually changes shape, however, becoming oblong, about twice as long as it is wide. By the end of this instar, a layer of spongy parenchyma three to four cells in thickness has been consumed, and the mines have reached their maximum size, averaging 17 mm. long and 12 mm. wide.

The larva, although still flattened, is now whitish opaque but moulting takes place in the same manner described for the earlier instars. The frass, however, is placed in a single or double row around the margin of the mine, as shown in Fig. 3. It is globular, smooth, and satiny black.

Fourth-instar Larva

Following the third instar, a complete change in body form takes place, and the fourth-instar larva appears with the cylindrical body and ventrally-directed mouthparts typical of lepidopterous larvae. The size of the mine now increases solely through the larva using its new mouthparts to attack the remaining spongy parenchyma, which allows it to move into the palisade layers, but only within the limits of the third-instar mine. Feeding in both the fourth and fifth instars is carried out in a unique manner, only one layer of cells being eaten at a time, and these cells are consumed in small blocks, as shown in Fig. 2C. The fourth-instar larva rarely penetrates into the upper layer of palisade cells leaving this for the fifth-instar larva.

The fourth-instar larva possesses spinnerets whereby a thin layer of silk is spun over the central portion of the upper or feeding surface of the mine. A comparatively heavy layer of silk is laid over the lower wall and as it contracts with drying, it draws the epidermis into a bulge or fold, thus forming the tenti-

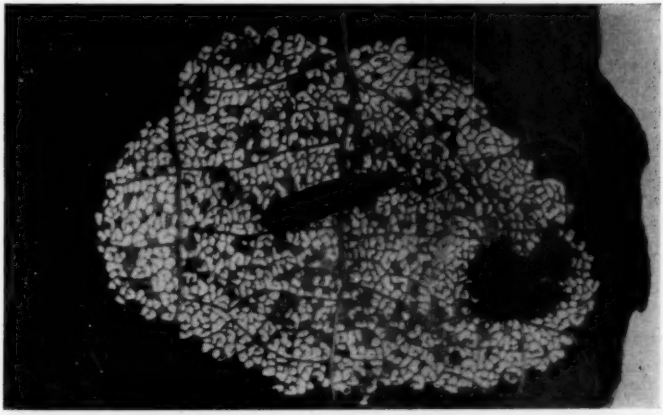

Fig. 3—Lower wall of mine removed to show pupa, fourth- and fifth-instar frass pile at right, and third-instar frass line around margin of the mine.

form mine typical of many leaf miners. A cross section of a tentiform mine is shown in Fig. 2C, and Fig. 4 shows the external appearance of the fold which appears as a ridge in the centre of the long axis of the mine. The contraction of the lower wall of the mine draws the upper wall into a convex shape, thus allowing the larva greater freedom of movement.

The larva is opaque white until late in the instar when the fifth, sixth, seventh, and eighth abdominal segments become citron yellow. A change in the method of moulting occurs at the end of this stage; the head capsule splits and the skin and capsule are shed in one piece. The frass is globular and dry with a more or less pebbled surface. It is black and is all piled in one spot, usually at one end of the mine, and is attached to the upper surface with silk (Fig. 3).

Fifth-instar Larva

The fifth-instar mine is easily identified, since the fourth-instar skin is tied to the top of the frass pile. Feeding continues in the palisade layers, which are eaten through to the upper epidermis although vascular bundles are avoided even at this late stage. The fifth, sixth, seventh, and eighth abdominal segments become darker citron yellow, probably in connection with the maturing of the gonads. The frass is similar to that of the preceding instar, and disposal is carried out in the same manner (Fig. 3). During the latter part of this instar, the larva spins a silken cocoon around itself. It is elliptical in shape and is usually placed in the central portion of the mine (Fig. 5).

Identification of Larval Instars by Mine Characteristics

It is apparent from the above descriptions of larval mines that the mine of each instar exhibits certain characteristics. These characteristics offer a simple means of identifying the larval instars, as follows:

A Mine flat—B
A1 Mine tentiform—E
B Frass deposited in one spot, usually in central part of mine—C
B1 Frass deposited in single or double row around margin of mine—D
C Frass elliptical, pointed at both ends; mine to 3 mm. in diameter ..... Instar I
C1 Frass globular; mine 3 to 6 mm. in diameter ..... Instar II
D Mine 6 to 17 mm. in length, usually oblong ..... Instar III
E Frass deposited at one end of mine, tied down with silk, no cast-skin on frass pile, feeding in palisade layer light ..... Instar IV
E1 Frass deposited at one end of mine, tied down with silk, cast-skin of fourth-instar larva on frass-pile, feeding in palisade layer advanced ..... Instar V

Pupa

The fifth and sixth abdominal segments of the pupa are free, and it is capable of considerable movement, and the silken cocoon, so large that it might well be termed a mat, allows a great deal of freedom. Immediately before the adult emerges, the pupa forces its way through the wall of the cocoon and the lower epidermis of the leaf by means of a sharply pointed protuberance on the head. The head and thorax then protrude from the mine, the remainder of the body being held within by setae on the abdomen. After emergence the empty pupal case remains in this position for several weeks, often until leaf fall (Fig. 4).

Adult

In most infestations in the Sault Ste. Marie district, very few individuals reached the adult stage due mainly to larval competition and parasitism. However, one isolated clone of 27 trembling aspen was found in which emergence was comparatively high, and these trees were used for studies of overwintering and spring activity. The trees, varying in height from 6 to 40 feet, were situated in a clearing about 85 feet in diameter, surrounded by a stand of red pine, *Pinus resinosa* Ait. with scattered jack pine, *Pinus banksiana* Lamb., white

Fig. 4—Empty pupal cases projecting from the lower walls of the mines. The tentiform folds are shown as ridges below the pupal cases.

pine, *P. strobus* L., white spruce, *Picea glauca* (Moench) Voss and balsam fir, *Abies balsamea* (L.) Mill. The ground-cover consisted of bracken fern, *Pteridium aquilinum* (L.) Kuhn, blueberry, *Vaccinium* sp., teaberry, *Gaultheria procumbens* L., haircap moss, *Polystichum* sp., and reindeer lichen, *Cladonia* sp.

The adults emerged in mid-August of 1954 and a thorough search of the whole area failed to reveal their hibernating sites. Moths were placed in cages over various types of ground cover, but the insects distributed themselves over the sides and tops of the cages, making no effort to enter the duff, humus layer, or soil. Cages containing adults were fastened over the limbs of several species of trees with similar results, except in the case of red pine in which the moths secreted themselves beneath the bark scales on the underside of the branch. It is, therefore, highly probable that this insect uses coniferous trees as hibernating sites, and that infestations are heavy only in situations where coniferous trees

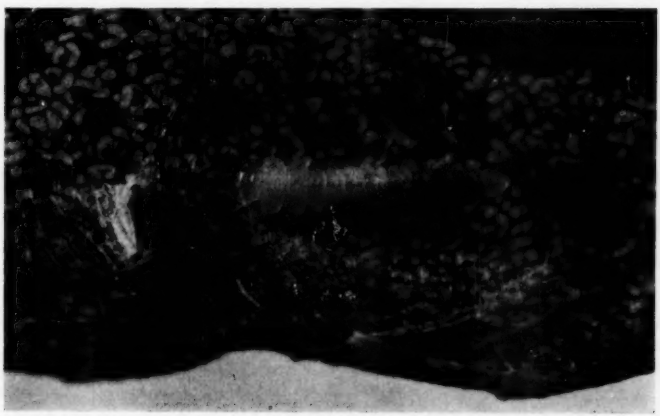

Fig. 5—View of the upper, inner surface of the mine. Fifth-instar larva is shown spinning cocoon.

are mixed with, or bordering on, aspen stands. This was true in all the infestations observed by the writer in the Sault Ste. Marie district. In several cases, extensive pure stands of aspen bordered by stands of conifers showed injury only in a narrow belt of trees immediately adjacent to the conifers. Observations made during the flight period in the spring of 1955 strengthened the probability of such a relationship. The moths spent the days resting on the coniferous trees, flying to the aspen each evening and returning to the pines, spruce, or fir in the morning.

The appearance of the adults in the spring closely followed the opening of the aspen leaves. In 1954, the leaves opened about June 1, and oviposition was completed before June 20. In 1955, the leaves were fully developed on May 9, and male moths were found on the foliage on May 11. The females appeared on May 13 and oviposition began at once. The last adults were seen on May 25.

Evening flights took place when the temperature ranged between 50° and 65°F., at light intensities, determined with a Norwood Director Meter, varying from 50 to 1000 foot-candles, and with little or no wind. The moths arose from resting places on the conifers, and moved 2 to 10 feet above the ground with a characteristic wavering flight to the trembling aspen. The greatest flight distance recorded was 107 feet measured to the centre of the aspen stand. The insects settled on the lowest foliage of the aspens and oviposition began at once. The females crawled from leaf to leaf and branch to branch, only very rarely using their wings. They moved very slowly upwards, and if the temperature remained above 40°F., activity continued all night. However, if the temperature fell close to freezing or below, most of the moths dropped to the ground. This habit of beginning oviposition each night on the lowest foliage and moving gradually upwards is reflected in the distribution of mines on the trees. Copulating pairs were seen only in the hours immediately before dawn, at temperatures in the vicinity of 40°F.

Morning flights began at temperatures of about 44°F. and were completed before the temperature rose to 50°F. The flights on warm, overcast mornings were gradual with no very noticeable peak, whereas on cold, clear mornings they were abrupt and quite spectacular. This suggests that when the temperatures are above 40°F. flight is activated by light, but when the temperatures are lower, light has little effect. The few moths that remained on the trees during cold nights were the first to take wing, and when the sun's rays warmed the ground cover slightly, the insects arose in clouds. They flew directly to the coniferous trees and settled down for the day, thus leaving the aspens and the ground-cover completely free of moths.

Although no conclusive evidence regarding fecundity can be given, five freshly-mated females placed in cheesecloth bags on branches of aspen deposited an average of 43.6 eggs. The sex ratio of 200 adults reared from pupae in August, 1954, was 1 male to 1.2 females. The sex ratio of field collected material during the flight period in May, 1955, varied with the time of collection. On the second night of the flight all the moths were males, but from that time until the end of the period the ratio based on 300 specimens collected was 1 male to 12 females.

Larval Competition and Parasitism

Two major factors, larval competition and parasitism, were observed to be operative in the natural control of this species. When two larval mines coalesced, one larva attacked and killed the other. As many as four mines were observed to merge, with only one larva surviving, and, in rare cases, the coalescence of mines resulted in the death of all larvae concerned.

Attacks were provoked by the introduction of larvae into tenanted mines, and the results were observed. The first larva to sense the presence of the other immediately attacked and killed it by tearing a hole in the central portion of the abdomen and consuming the body fluids. The larva on the defensive did not, as a rule, put up much resistance. The size of the larva involved did not seem to have any bearing on the outcome of the struggle, the smallest individual often being the victor. In the first and second instars, the bodies of the dead larvae were usually moved to the frass pile, whereas in the third instar they were moved to the margin of the mine.

Larval competition occurs only in the first three instars, since the mines do not enlarge horizontally during the later instars. It is probably safe to assume that competition is at its height during the second and early part of the third instar, by which time the mines have reached a fair size and are enlarging rapidly.

Parasites were observed inserting their eggs into the mines during the latter part of June. They caused light mortality in the second instar, and steadily increasing mortality during the third, fourth, and fifth instars, and the pupal stage. They were mainly ectoparasites and were usually attached to the abdomen of their host. They all pupated in the mines and emerged as adults from the latter part of July to the middle of August. Eight, and possibly nine species were recovered.[2] All were Hymenoptera and one species was new to science. The parasite material was identified by the Systematic Entomology and Biological Control Unit, Entomology Division, Ottawa.

The following species of parasites were recovered:

Apanteles n. sp. No. 74 was one of the commonest parasites encountered in the early larval stages (up to the end of the third instar). It pupated in the mine in an elliptical silken cocoon which was flattened dorso-ventrally and attached by its dorsal side to the upper surface of the mine.

Apanteles ornigis Weed was a parasite of the early larval stages and pupated in the mine in a cocoon similar to that described above. This species was not common.

Cirrospilus cinctithorax (Grlt.) was probably the most abundant parasite at the time of this study. It was parasitic on the early larval stages. It pupated in a cylindrical silken cocoon, pointed at both ends, which was fastened to the lower wall of the mine by silken threads.

Pnigalio tischeriae (Ashm.) was a common parasite of the larval stages and pupated naked in the mine.

Pnigalio sp. (? *tischeriae*) appeared with the above species.

One unidentified species of the family Eulophidae attacked the larval stages and pupated naked in the mines.

Closterocerus sp. (near *trifasciatus* Westw.) was a common parasite of the late larval and pupal stages; and pupated naked in the mine.

Alophosternum foliicola Cush. was a common endoparasite emerging from the pupa of the host.

The actual importance of larval competition and parasitism in the Sault Ste. Marie district was determined quantitatively by direct observation of marked mines. The eggs on 25 leaves on each of ten trees were counted, and the leaves were labelled immediately following oviposition. Development was followed throughout the summer. A total of 1,479 eggs were recorded, and 1,422 of these

[2] *Sympiesis nigripes* Ashm. was recovered by L. A. Lyons, Forest Insect Laboratory, Sault Ste. Marie, from collections of *L. salicifoliella* near Port Arthur, Ontario, in 1949, but was not recovered during the present study. Personal Communication.

TABLE II

Life Table for the 1954 Generation of the Aspen Blotch Miner at Sault Ste. Marie, Ontario

Age Interval	No. alive at beginning of X	Factor responsible for dX	No. dying during X	dX as Percentage of lX
X	lX	dXf	dX	100 qX
Egg	1479	Failure to hatch	57	4
Instar 1 and 2	1422	Larval competition	623	44
		Parasites	3	0.2
		Total	626	44.2
Instar 3	796	Larval competition	179	22
		Parasites	166	21
		Total	345	43
Instar 4 and 5	451	Larval competition	0	0
		Parasites	357	79
		Other	75	17
		Total	432	96
Pupa	19	Parasites	9	47
		Other	2	11
		Total	11	58
Adult	8		–	–

NOTE: Mortality due to causes other than larval competition and parasitism in the first three instars was not recorded. It would not exceed that of the later stages, and is believed to be considerably less. It is included with the mortality listed for larval competition. The general arrangement of the above life table follows that of Morris and Miller (1954).

hatched. Eight individuals, or 0.5 per cent of the population, succeeded in reaching the adult stage. Fifty-three per cent of the mortality was due to larval competition, and 36 per cent to parasitism. A breakdown of these figures by stages is shown in Table II, and is depicted in histogram form in Fig. 6. Larval competition can be considered a very important factor in the natural control of this species, particularly during heavy infestations. However, regarding parasitism, it must be emphasized that these observations were made in an infestation that had passed its peak and was declining quickly, and therefore this factor would be exerting its greatest influence at this time.

Insect—Host Relationships

An analysis of the data included with 842 collections, taken during the period 1951 to 1954 by the Forest Insect Survey of Ontario, provides valuable information regarding the site preferences of this insect (Fig. 7). It is apparent that this insect exhibits a decided preference for young trees under 4 inches diameter-breast-height, growing in partial shade, open, or fringe situations, on flat terrain.

Observations were made in the Sault Ste. Marie district to determine the distribution of the mines in the trees. Heavy, medium, and light infestations were selected, and sampling was carried out by selecting one 18-inch branch from each of the four quadrants of each tree in the clone at four levels, 4-10 feet, 10-15 feet, 15-20 feet, and 20-30 feet. One hundred leaves were picked from the four branches of each level, and the number of larva in each sample was determined from the dried leaves in the laboratory. Fig. 8 shows that the

average number of mines per leaf, the percentage of total number of mines, and the percentage of leaves mined, all reached their highest values in the lower crown levels of the trees in heavy, medium, and light infestations. This distribution is explained by their method of oviposition, which has already been described.

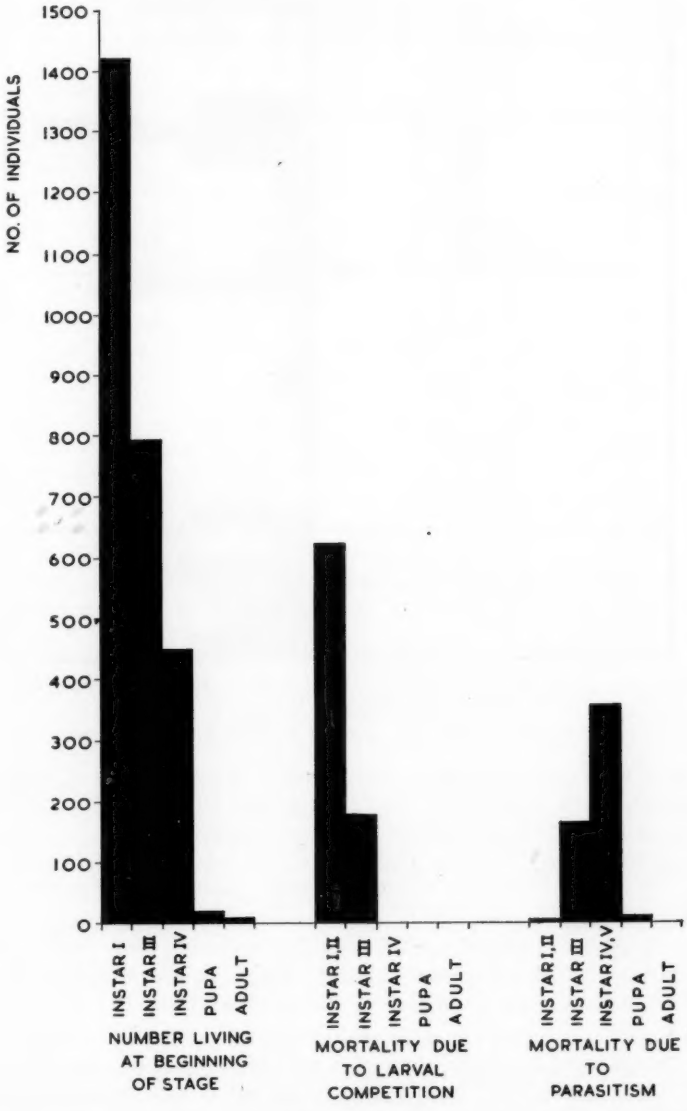

Fig. 6—Mortality of larval and pupal stages of *Lithocolletis salicifoliella* due to larval competition and parasitism.

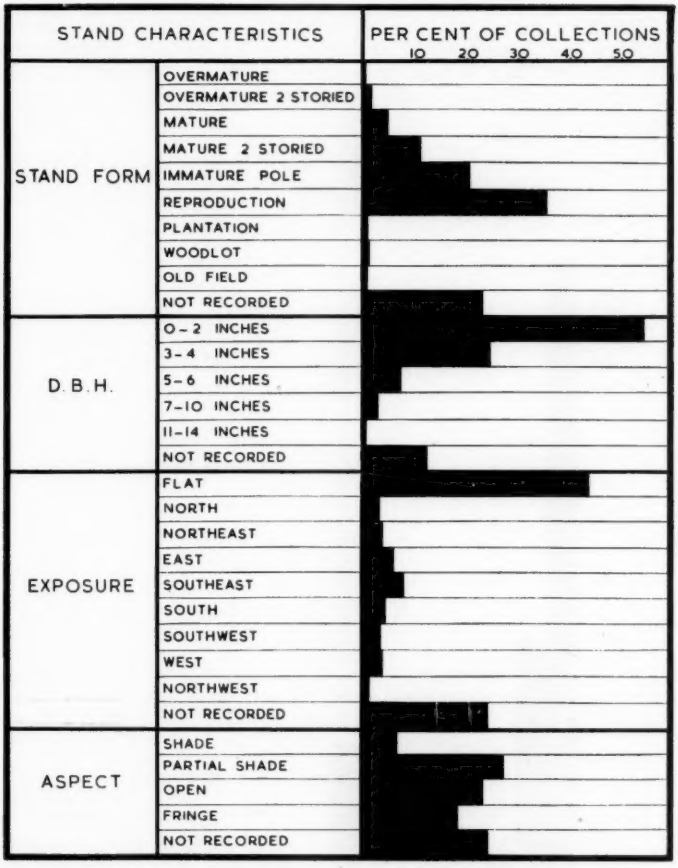

Fig. 7—Site preferences of *Lithocolletis salicifoliella* from an analysis of 842 collections of the Forest Insect Survey.

This information, as well as conclusions drawn from Fig. 7, leads to the conclusion that the aspen blotch miner would not be expected to cause serious injury to other than reproduction or polewood stands.

Summary

The aspen blotch miner, *Lithocolletis salicifoliella* Cham., appeared in infestation proportions in Ontario west of Lake Nipigon in 1944. By 1951 it had spread over the whole of Ontario, Manitoba, Saskatchewan, and part of Quebec. Since then, it has declined to a place of minor importance.

The eggs are laid on the underside of the leaves in May or June. There are five larval instars, the first three of which are of the flat type, and the last two of typical cylindrical form. The larval instars can be differentiated by frass and mine characteristics. Pupation takes place in the mine. The adults emerge in late summer and overwinter.

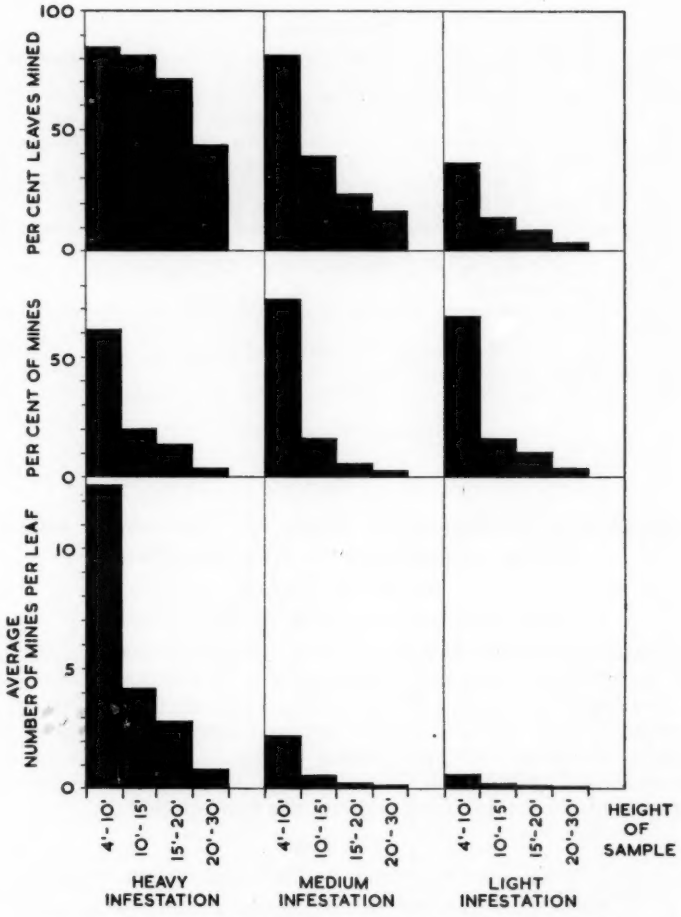

Fig. 8—Vertical distribution of mines of *Lithocolletis salicifoliella*.

The preferred host in Ontario has been *Populus tremuloides*, but the insect has been found occasionally on *P. grandidentata*, *P. balsamifera*, and *Salix* sp. Site preferences were distinct. Foliage below 10 feet in height, on trees less than 4 inches d.b.h., growing on flat terrain, in partially shaded, open, or fringe situations suffered the greatest injury.

Two natural control factors, larval competition and parasitism, caused 89% mortality of the 1954 generation in the Sault Ste. Marie district. Larval competition accounted for 53%, and parasitism for 36% of the mortality. Nine species of Hymenopterous parasites were recovered.

Acknowledgments

The author wishes to thank D. R. Wallace for his many helpful suggestions during the course of this study. Special thanks are also due to O. H. Lindquist and M. F. Kelley for their assistance in the laboratory. The advice and encouragement of R. M. Belyea and W. L. Sippell is much appreciated.

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(Received March 27, 1956)

A Description of the Immature Stages of *Lithocolletis salicifoliella* Cham. (Lepidoptera: Gracillariidae)[1]

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No detailed description of the larva of any member of the genus *Lithocolletis* exists in the literature, although various aspects of the structure of one or more species have been described by Wood (1900), Trägårdh (1913), Fracker (1913), and Peterson (1948), and the relation between structure and habits has been examined by Needham (1928) and Hering (1951). Martin (1956) has discussed the bionomics of *L. salicifoliella* Cham. The present contribution forms a complementary study of the immature stages of this same species.

The Egg

The egg is ovoid and hemispherical. Its lower surface is flat and adheres tightly to the leaf. The upper surface is opalescent when seen in reflected light; the surface is smooth with a finely reticulate pattern. Length, 0.35 mm., width 0.27 mm.

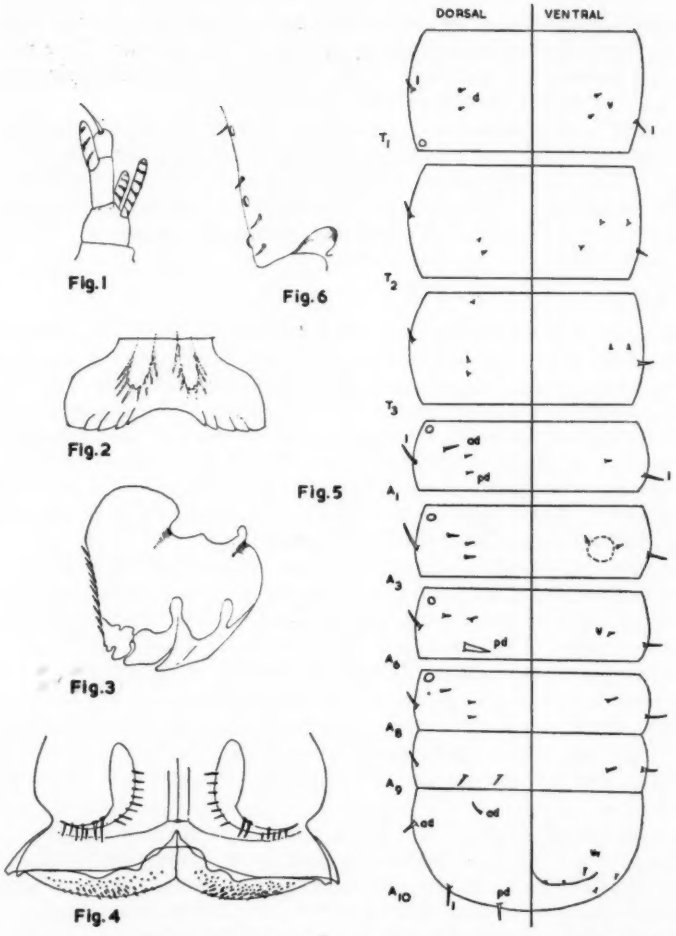
The Larva

In all the instars the larva is creamy white except, as has been pointed out by Martin, late in the fourth and throughout the fifth instar when the fifth to eighth abdominal segments become bright yellow. This is probably due to fat accumulating around the gonads.

First Instar

The larva is depressed, with a small head, broad thoracic segments, a slightly tapering body, and a rounded anal region. The head (Fig. 15) is widest behind the middle, about one-third wider than long, and with the base one-third wider than the width across the bases of the antennae. There are no setae that are constant; when present, those on the lateral surface are very short. Ommatidia are not visible. The antennae (Fig. 1) have three segments: 1st, cylindrical with two long papillae; 2nd, longer than wide, produced at the inner corner, with one

[1]Contribution No. 273, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.



Figs. 1-6. 1, antenna, first instar; 2, labrum, first instar, dorsal; 3, mandible, first instar; 4, hypopharynx and labium, first instar, dorsal; 5, setal pattern second instar -T_1-T_8, thoracic segments; A_1-A_{10}, abdominal segments; l, lateral setae; pd, postero-dorsal setae; v, ventral setae; 6, ommatidia on edge of head capsule, third instar.

long sensory papilla; 3rd, minute, rounded, supporting a long slender seta at the apex. The mouthparts are prognathous and highly modified. The labrum (Fig. 2) is widest at the apex, bilobed, with a shallow, central emargination; the apical margin has from seven to ten teeth on each lobe, and from the base of each tooth a ridge extends along the ventral surface. The mandibles (Fig. 3) are broad across the base, almost quadrate, with a greatly expanded mesal angle, and with a series of three large and one small teeth across the apex; the mesal margin bears a row of setae. The hypopharynx (Fig. 4) is broad, bilobed, shallowly but acutely emarginate, and the surface is covered with minute setae. The labium (Fig. 4) is broader than the hypopharynx at the base, without setae, and bears

a pair of heavy, setaceous, arcuate ridges on its dorsal surface. On each ridge is a pair of long setae, which may represent maxillary structures (Trägårdh, 1913).

The prothorax is twice as wide as the head. There is an annular spiracle just below the lateral line at each posterior corner of the segment. The mesothorax is similar, but lacks the spiracles. The metathorax also lacks spiracles, and is shorter and somewhat narrower than the mesothorax.

The first seven abdominal segments are clearly defined. The eighth is not distinct from the ninth and tenth, the three segments together making a compact anal mass. The anus is a simple longitudinal slit, the sides of which are slightly divergent posteriorly. Spiracles are occasionally present on segment seven; they have not been located on the other abdominal segments. There are no regular body setae. No legs are present.

Second Instar

The larva (Fig. 16) is flattened, head narrow, thorax broad, with the body tapering behind it to a rounded anal section. The head capsule is one-third wider than long, and is widest behind the middle. It is more elongate than that of the first instar, with a relatively narrow frontal region. The antennae are similar to those of the first instar, but the segments are larger and the basal segments are set into sockets on either side of the frons. The frons projects more than in the first instar, and the mouth-parts, while similar to those of the first instar, are more expanded. Ommatidia are not visible. Occasionally some short setae are found on the lateral aspect of the head capsule.

The thorax is slightly wider than the base of the head and tapers to the first abdominal segment. The prothorax is longer than the mesothorax, is slightly wider, and bears a vague, central, dorsal shield, which, when visible, is divided by a median line. The meso- and metathorax are similar; both are equal in width to the prothorax, and have vague, undivided, dorsal shields.

Thoracic legs and prolegs are not developed; however, the positions of the legs can be found as rather smooth circular areas on the ventral surface of the thoracic segments, and on abdominal segments three to five, and ten. Spiracles are annular, and are present on the prothorax and the first eight abdominal segments.

Thoracic setation (Fig. 5). Each thoracic segment bears the following setae: dorsal setae (d)—two moderately long setae in the posterior half of each segment between the dorsal and lateral lines; lateral setae (l)—two longer setae in the lateral area, the upper one anterior to the lower; ventral setae (v)—two short setae between the lateral and ventral lines, the posterior one in transverse line with the posterior lateral seta. Auxiliary setae are sometimes present at the anterior edge of the dorsum of each segment between the dorsal and lateral lines. In the mesothorax there are three pairs of ventral setae, a pair transverse and antero-ventral to the posterior lateral seta, and one directly ventrad of the posterior lateral seta and more mediad than the anterior ventral setae. In the metathorax the ventral setae are like those of the mesothorax but the posterior ventral seta may be absent.

Abdominal setation (Fig. 5). The first seven abdominal segments are similar: antero-dorsal setae (ad)—two in a transverse line across the middle of the segment, the outer seta being slightly longer than the inner; postero-dorsal seta (pd)—a single seta the same length as, and posterior to, the inner antero-dorsal seta; lateral setae (l)—two moderately long setae along the lateral line, the upper seta being slightly anterior to the lower and in line with the spiracle; ventral setae (v)—one single seta between the lateral and ventral lines in the

segments not bearing prolegs anlagen, the two short setae, one on the inner and one on the outer side of each proleg anlag in the proleg-bearing segments. There may be very minute auxiliary setae at the anterior edge of each segment between the dorsal and lateral lines. On the sixth segment the postero-dorsal seta is greatly enlarged and slightly more lateral in position. On the ninth segment

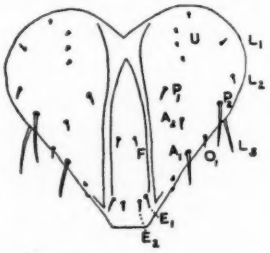


Fig.7

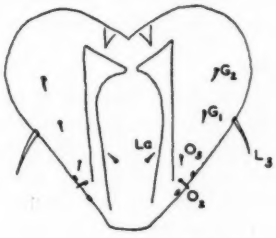


Fig.8

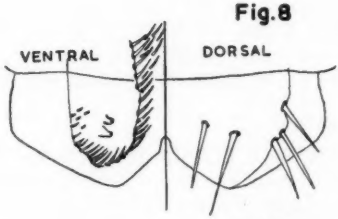


Fig.10

Fig.9

Fig.11

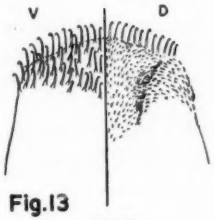


Fig.13

Fig.12

Fig.14

Figs. 7-14. Fifth instar: 7, head capsule, dorsal; A, anterior setae; E, epistomal setae; F, frontal setae; L, lateral setae; O, ocellar setae; P, posterior setae; U, ultraposterior setae; 8, head capsule, ventral; G, genal setae; L, lateral setae; La, labial setae; O, ocellar setae; 9, antenna; 10, labrum; 11, mandible; 12, maxilla 13, hypopharynx; 14, labium and spinneret.

the dorsal setae are reduced to two in a transverse line. The two lateral setae continue this line around the body where it terminates with two short ventral setae. On the rounded tenth segment the setae are arranged around the edge of the epiproct. The first antero-dorsal seta is near the anterior edge of the epiproct between the dorsal and lateral lines. On the free edge, beginning at the apex, are the postero-dorsal seta, one lateral seta, and the second antero-dorsal seta. Four ventral setae are arranged in a group laterad of the proleg anlag. At the base of the proleg anlag are two short, sharply-pointed spines.

Third Instar

The larva of this instar is more cylindical than that of the first two, and the setae are longer. The mouth-parts and the shape of the head capsule are as in the earlier instars. Ommatidia (Fig. 6) can be found at the antero-lateral corner of the head capsule; they are arranged in a line with the first and second closer to each other than are the second and third.

The arrangement of the setae is similar to that found in the second instar. On the dorsum of the eighth segment, along the posterior edge, is a low crest of pointed spines. A longer crest of similar spines is found across the anterior edge of the ninth segment.

Prolegs and thoracic legs are not yet developed beyond the anlagen stage.

Fourth Instar

The larva is cylindrical in the fourth instar, and prolegs, thoracic legs, and true, biting mouth-parts are well-developed. The head capsule is almost as wide as long, widest in front of the base, with the base slightly wider than the front margin. These structures are similar to those found in the fifth instar, and more detailed descriptions will be found below.

Thoracic legs consist of a raised base and three fleshy segments, the distal one being very small. Each segment bears one or more stout setae. A single claw, at the apex of the third segment, is slightly curved from a wide base, from which there arises also a minute tooth.

The abdominal prolegs are only slightly protuberant. Each bears two opposing rows of uniseriate, homeoidious crotchets; the total number of crotchets ranges from 6 to 8. The anal prolegs differ by being strongly protuberant, and having a single circle of multiseriate crotchets, which may vary from 30 to 38 in number.

Body setae are well-developed. This is especially true of the lateral setae, which are long and form a sparse fringe along each side of the body. Setation is similar to that found in the fifth instar.

Fifth Instar

The larva of this instar (Fig. 17) is cylindrical like that of the fourth instar. The head capsule is widest slightly behind the middle, with the base only slightly longer than the frontal margin. Setae are well-developed on the head-capsule. The antennae (Fig. 9), at the antero-lateral corners of the head-capsule, are set into shallow sockets. Each antenna is composed of three large and one very small segment. The first segment is cylindrical. The second is also cylindrical, slightly shorter than the first, and bears on its distal surface the third segment, two spirally-marked basiconica, one microseta, and one short and one long macroseta. The small third segment bears a short basiconicum, a microseta, and a small fourth segment, which is hardly more than a base for a stout, long seta.

There are three large ommatidia which appear as clear, oval areas near each antero-lateral corner of the head-capsule. The first is on the ventral-lateral

margin of the capsule near the base of the antenna, the second is behind and laterad of the first, and finally, the third is behind and dorsal to the second. The ommatidia are separated from each other by their own lengths.

The labrum (Fig. 10) is bilobed, with each lobe slightly angulate at the side. The cleft in the middle of the front margin is moderately deep, with a round hole at its apex. On the dorsal surface there are five large setae arranged more

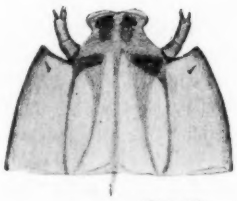


Fig.15

Fig.16

Fig.17

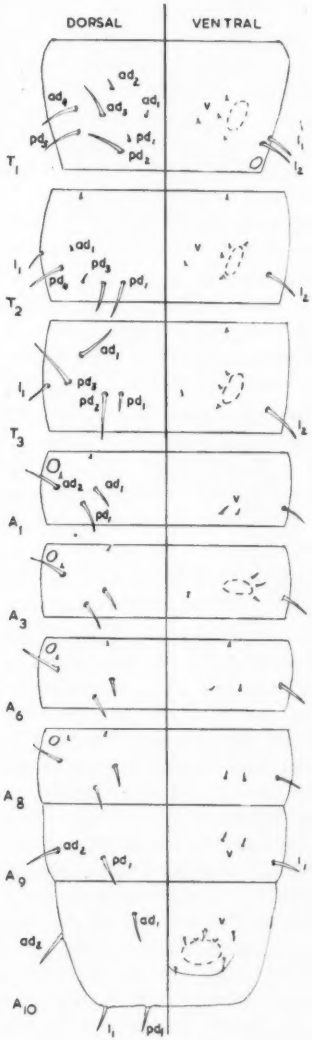


Fig.18

Figs. 15-18. 15, head capsule, first instar x 420; 16, second-instar larva x 107; 17, fifth-instar larva x 25; 18, setal pattern, fifth instar; ad, antero-dorsal setae; l, lateral setae; pd, postero-dorsal setae; v, ventral setae.

or less in a semicircle around the edge of each lobe. On the ventral surface of each lobe is a raised crest around the edge of which is a row, or fringe, of short setae. Also, on the surface of each crest is a pair of truncate papillae.

The mandibles (Fig. 11) are quadrate, with a deep truncate base, and five long teeth along the apical margin. Of these teeth the more distal are curved and slender. On the outer edge of each mandible may be found one or two long setae.

The maxillae (Fig. 12), which appear first as definitive organs in the fourth instar, each consist of a large basal segment, and a short irregularly-shaped second segment from which arise a massive segment and a palp. The basal segment bears a long seta near its distal margin. The second segment bears, on its inner corner, a long, stout seta. From the outer corner of this segment arises the long cylindrical palp, which is truncate at the apex and bears three slender microsetae and a short basiconicum. Also from the second segment arises a massive segment, the mala, which bears two setae and a pair of low prominences, each supporting a very short basiconicum.

Between the maxillae, and above the labium, lies the broad hypopharynx (Fig. 13). On its ventral surface, in the apical third, is a mass of long, hooked setae. On the dorsal surface these are replaced by a thick mass of minute, sharply-pointed setae; these setae point towards the apex along the lateral margins and away from the apex in the central portion, which is sunken as a trough.

The labium (Fig. 14) consists of a broad basal portion, a pair of palpi, and a central triangular segment. The palpi consist of two segments; the first is long and cylindrical and bears a long spine, the second is very small and also bears a long spine. The central triangular sclerite can be assumed to be the mentum or, at least, part of it. Ventral to the labium is a narrow, roughly cylindrical structure, the spinneret. This organ narrows to a bifurcate apex.

A poorly-defined thoracic shield is found on the prothorax, whereas there is a small one on the mesothorax and a slightly larger one on the metathorax.

Head-capsule setation. On the top of the head-capsule (Fig. 7) is a crescent of four minute setae, the ultraposterior setae (U). The posterior setae are two in number; the first (P_1) is near the adfrontal suture, slightly posterior of the mid-line of the head; the second (P_2) is very long, near the lateral margin of the head and slightly anterior to P_1. There are two anterior setae: the first (A_1) is long, in the anterior angle of the head-capsule and dorsal to the ommatidia; the second (A_2) is minute, directly posterior of A_1 about half way between A_1 and a line between P_1 and P_2. There is a frontal seta (F) about half-way between the apex of the front and the epistoma. At the edge of the front, on the epistoma, is a pair of epistomal setae; the outer (E_1) is slightly longer than the inner (E_2). There is one ocellar seta (O_1) on the dorsal surface; it is above the ommatidia between A_1 and the long third lateral. The laterals form a series of three setae along the lateral margin of the head: the first (L_1) is laterad of the ultraposterior setae; the second (L_2) is minute and directly laterad of P_1; and the third (L_3) is long, ventral and anterior to P_2. On the ventral surface (Fig. 8) of the head-capsule are two ocellar setae (O_2 and O_3) just below the ommatidia, two genal setae (G_1 and G_2), and a moderately long labial seta (La).

Thoracic setation (Fig. 18). On the prothorax the dorsal setae can be divided into an anterior (ad) and a posterior (pd) row: ad_1 and ad_2 are quite small, the second being anterior to the first; ad_3 is as long as ad_4 and slightly posterior to it; pd_1 is minute and just antero-mediad of pd_2; pd_2 is long; pd_3 is long and posterior to ad_4. The lateral setae (l_1 and l_2) are in an oblique line

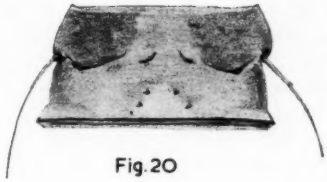


Fig. 20

Fig. 21

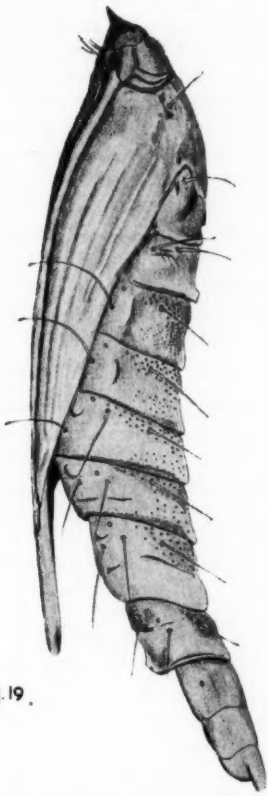


Fig. 19.

Figs. 19-21. 19, pupa, lateral aspect; 20, seventh segment, ventral surface; 21, apical segments, ventral surface.

anterior to the spiracle. A line of three ventral setae (v) is found on the inside of the base of the leg, and a more median seta is also present. On the mesothorax there is but one antero-dorsal seta (ad_1). Behind this is a row of four long postero-dorsal setae, pd_4 being slightly anterior to the other three. There is a minute auxiliary seta at the anterior edge of the segment directly in front of ad_1. Of the lateral setae, l_1 is shorter, more dorsal, and slightly anterior of l_2. There are five ventral setae (v), four of which are positioned as in the first segment, whereas the fifth is at the anterior edge of the base of the leg. An auxiliary seta is sometimes present at the anterior edge of the segment dirctly in front of the leg. In the metathorax the ventral and lateral setae are like those of the mesothorax. The dorsal setae are four in number: ad_1 is in the anterior half of the segment near the lateral border; pd_1 is shorter and more mediad than the rest; pd_2 is laterad of pd_1 and longer; pd_3 is longer than pd_2 and more laterad than ad_1.

Abdominal setation (Fig. 18). On the abdomen the majority of the setae are relatively stable. There are two, long, anterio-dorsal setae (ad_1 and ad_2) on each segment and one postero-dorsal seta (pd_1), behind and slightly laterad of ad_1. In addition, there is a small auxiliary seta at the anterior edge of each segment in front of ad_1, and a second one between ad_2 and the spiracle. This

last auxiliary seta is more anterior on segment eight and forms nearly an equilateral triangle with the spiracle and ad_2. Laterally on each segment there is a single long seta (1), which is slightly ventral to, and posteriorly distant from, the spiracle. Ventrally, on the segments devoid of prolegs, there is a pair of setae on the posterior half of the segment. On some segments there is also a very small anterior auxillary seta. On the segments bearing prolegs there are three setae at the outside edge of the base of the proleg and a single seta in a median position. Ventrally the ninth segment resembles the other legless segments. Dorsally however, the auxiliary setae are missing as is ad_1. The remaining setae are arranged in a transverse ring around the body. On the epiproct ad_1 is antero-median, ad_2 is on the lateral edge of the epiproct anteriorly, 1_1 and pd_1 are on the apex with pd_1 more mediad. Ventrally there are five short setae around the anal prolegs, three anterior, one lateral, and one median. In addition there are two small spines at the anterior base of each proleg.

The Pupa

The pupa (Fig. 19) is elongate, slender, and cylindrical. It is about 4.5 mm. long. The colour varies from pale to dark brown.

The head is conical, with a high point dorsal to which is an oval, elongate sulcus. Between the eyes, at the base of the front, is a double seta, probably replacing the pair of epistomal setae in the larva. The antennae extend to the ends of the wing pads.

The pronotum is present only as a narrow sclerite in front of the broad mesonotum. The mesonotum has a single long seta at each antero-lateral corner near the base of the wings. In the postero-lateral corner is a deep fovea marking the position of the mesothoracic spiracle. From the sides of the mesonotum the fore-wing pads fold down over the lateral surface of the body and extend ventrally back to the middle of the fifth abdominal segment. The metathorax is smooth like the mesothorax, and bears a similar long seta in each antero-lateral corner. Its anterior edge, however, is deeply emarginate. The legs are slender and elongate, extending to the middle of the eighth segment.

Of the abdominal segments the first is like the metathorax dorsally. It bears two long setae near the anterior margin. Segments two to seven are alike in having the dorsal surface asperate with the asperites sharply pointed. The second and third segments have two setae each, whereas the fourth to the seventh have three. The seventh segment (Fig. 20) has on the ventral surface a triangular area on each anterior side of which there are two or three low spines.

Segments eight to ten of the abdomen are cylindrical, narrower than those in front, and are without setae. The cremaster is smooth and truncately rounded at the apex. Ventrally the ninth segment is emarginate on the posterior edge; at the base of the emargination are two short spines. The genital opening, on the eighth segment, is in the form of a sinuate line set into an irregular sulcus (Fig. 21).

Discussion

One of the most striking structural changes that takes place from one instar to the next is in the shape of the head-capsule. In the first instar (Fig. 13) the capsule has evenly rounded sides, and anterior and posterior margins that are nearly equal; it is, thus, very similar to the normal lepidopterous head-capsule. In the second instar (Fig. 14), however, there is a radical change in the capsule shape. The anterior margin is only half as long as the posterior. From the widest point of the capsule the sides narrow abruptly to the anterior margin giving the capsule a rather constricted appearance in the apical third. This shape is retained in the third instar. In the fourth and fifth (Fig. 15) instars,

the head-capsule is again rounded, with the anterior and posterior margins less unequal. The shape differes from that of the first instar because the apical region still retains a slightly constricted appearance.

This change can be explained. In the first instar, in which the head-capsule is most nearly like that of other lepidopterous larvae, adaptive modification has not yet occurred. In the second and third instars, however, the elongate, wedge-shaped capsule is clearly an adaptation to the type of feeding. In the fourth and fifth instars, the rounded head-capsule is an attempt to return to the normal as the feeding habits and the type of mine change (Martin, 1956).

In the foregoing description the setae on the thorax and the abdomen have been given names roughly on the basis of their position. No attempt has been made to relate their names to the nomenclature prepared by Fracker (1913). To do this would be to impose upon an apparently unstable pattern a rigid interpretation. Until many more species have been examined and compared, the application of any rigid system of nomenclature is not advisable. The setae of the head-capsule are, on the other hand, fairly comparable with those of other Lepidoptera.

Aside from the obvious adaptations seen in the form of the mouth-parts and in the general shape, the larva shows other structural changes directly associated with its habits and habitat. In the first instar, the presence of long setae would be a decided detriment in a mine scarcely deeper than the larva itself; there are consequently no setae of importance. In the second and especially the third instars, when the mine is being excavated to a depth somewhat greater than that of the insect, some form of stabilizing organ would be advantageous; setae are then well-developed. In this regard, it is interesting to note the postero-dorsal setae on the sixth abdominal segment. This pair of setae is enlarged in both the second and the third instars. Particularly since the larva lies inverted while feeding, it is more than likely that this pair of setae acts as a brace that can be anchored into the plant tissue to prevent the larva from slipping backwards while feeding. Whether these can be moved voluntarily was not established; there is no visible difference other than size between these and other setae. In the third instar there is a pair of transverse ridges of spines, one on the anterior margin of the ninth segment and one on the posterior margin of the eighth. These ridges also aid in stabilizing the larva in the mine.

In the fourth and fifth instars the larva becomes more typically lepidopterous, the supporting mechanisms of the earlier instars having been replaced by thoracic legs, prolegs, and a spinneret. This again can be related to the change in the type of mine that is formed in these later instars. With a silk-spinning mechanism the larva can lay down a web of silk over the roof of the spacious teniform mine, and can suspend itself therefrom by the proleg crochets and thoracic leg claws.

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(Received March 27, 1956)

Cone-Infesting Lonchaeids of the Genus *Earomyia* Zett., with Descriptions of Five New Species from Western North America (Diptera: Lonchaeidae)[1]

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Study of lonchaeid material reared from cones of various coniferous trees in North America revealed five previously undescribed species of the genus *Earomyia* Zett. The composite nature of cone-infesting lonchaeidae has not been understood and at least four of the species treated here have been considered as a single species (Keen, 1938, 1952). Much of the material studied, particularly that reared by various Forest Insect Investigations officers of the United States Bureau of Entomology and Plant Quarantine (bearing Hopkins U.S. numbers), has been misidentified as *Earomyia viridana* (Mg.) (Keen, *op. cit.*), *Lonchaea albitarsis* Zett., *L. rufitarsis* Macq., *L. polita* Say, and others.

This paper is on the taxonomy and nomenclature of the adults of the five lonchaeid species–all of the genus *Earomyia*–most commonly reared from cones in North America, and brings together the information known about their respective habits. At this time I have no reliable records of any other lonchaeid species as primary pests of cones. It is suspected, however, that some additional members of the genus *Earomyia* do have food habits similar to those of species described below.

A number of species described from the Palaearctic region, e.g., *E. schistopyga* Collin (Collin, 1950), *adriatica* Becker (Hennig, 1948), appear to be closely related to certain of the Nearctic cone-feeding *Earomyia* species but nothing is reported concerning their habits. Reports in the European literature of rearing *E. viridana* from cones of fir (Seitner, 1925), larch (Seitner, 1929), and spruce (Kengas and Leskinen, 1943) are probably all based on misidentifications for *viridana* does not appear to belong among the cone-feeding species; it is much more closely related to the Nearctic species *E. aberrans* Mall., which has been reared from thistle heads, than to any of those reared from cones. Concerning the record of "*Spermatolonchaea inquilina* Hendel" reared from spruce cones (Kengas and Leskinen, 1943), I, like Hennig, (Hennig, 1948), can find no trace of such a species ever having been described.

Superficially, members of the family Lonchaeidae resemble small, shining, blue-black anthomyids, muscids, or calliphorids. The halteres are always black and the females have a long piercer-type ovipositor as in the Trypetidae and Otitidae. Species of the genus *Earomyia* (Figs. 6 and 7) have a bare lunule and the scutellum has a number of hairs in addition to the four scutellar bristles. The adults are rarely seen in nature, and almost all of the specimens studied have been obtained by rearing them from the larval stage in infested cones.

Although much of the ecology of the individual species remains to be discovered, a number of basic biological traits became apparent during this study. First, it is possible that several species live in the same cone at the same time. If this is confirmed the relationships between the species, and also between the species and the parts of the cone, need to be established. Secondly, some of the species require two or more years to complete their life-cycles whereas others mature in one year. Thirdly, some species feed in cones of a single species of conifer and others are adapted to living in those of a considerable number of

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coniferous species. Fourthly, each species seems to have a different distribution which is probably related to the range of the host tree or trees. More details on the life cycles, hosts, and distribution are given in the discussion of each species.

Concerning the material bearing Hopkins U.S. numbers, I had difficulty in interpreting the date, or dates, attached to the specimens. Not all of the data on certain specimens could be correlated with that on the original Hopkins cards filed at the U.S. National Museum. Mr. F. P. Keen, Special Assistant at the California Forest and Range Experiment Station, Berkeley, Calif., who has been intimately associated with this work for many years, has explained (*in litt.*) the system used as follows:—

"If a lot of infested cones from a given species of tree were collected from a given locality on a certain date, this collection was given a Hopkins number—say 13228. Maybe additional cones were collected from the same trees periodically during the year. If so, the same Hopkins number was used but a lot number was added. Under 13228, collections were made at nearly weekly intervals until lot 16 was collected, when the cones were mature and put in rearing. The different insect species found in the cones were given subletters—a letter for each species recognized. Usually in the fall of the year few adults were found but the following spring emergence would occur from rearing cages. The number of adults of a given species emerging day by day was recorded on a card under the lot number and letter designating the species; but the individual specimens were not labelled as to date of emergence and they were all put together in a vial of alcohol or in a killing jar with others of their kind. It would have been difficult to keep them separate as emergence ran into hundreds of specimens during a spring period. The Hopkins card then consisted of:

"(1) A collection card describing the cone material, locality, date, collector, and kind and condition of material;

"(2) rearing record cards by subletter for each species;

"(3) record of material sent to Washington for identification, number of specimens, date sent, and original collection data (date of emergence usually not shown).

"Thus one has to go back to the rearing records to find the period of emergence. If it later develops that more than one species was recorded under one letter, there is no way to obtain emergence data for the individuals. Under the Hopkins note system individual emergence records could have been kept, but it was not done in this case."

The dates quoted below for collection and emergence of specimens were obtained from the original rearing records and thus do not necessarily agree with dates attached to the specimens. (Often the date attached to the specimen refers to the date it was sent to Washington for identification).

Key to Adults of *Earomyia* Species Reared from Cones of Western Conifers

1. Tarsi entirely dark brownish-black ..... *aquilonia*
   At least first segment (metatarsus) of each tarsus yellowish-orange 2
2. Eyes pubescent; cheeks wide (Fig. 6) 3
   Eyes bare; cheeks narrow (Fig. 7) 4
3. At least first two segments of each tarsus yellowish-orange; epandrium of male genitalia boot-shaped and with a group of upcurved setulae arising from the "toe" (Fig. 20); ovipositor short (Figs. 3, 7, and 9) ..... *abietum*
   Only first segment of each tarsus orange; epandrium of male genitalia not boot-shaped and without a group of long, upcurved setulae (Fig. 15); ovipositor very elongate (Figs. 2, 6, and 11) ..... *longistylata*

4. Notopleuron with at least several setulae in addition to the two notopleural bristles (Fig. 7) ..... *brevistylata*
Notopleuron bare except for the two notopleural bristles ..... *barbara*

Earomyia abietum new species

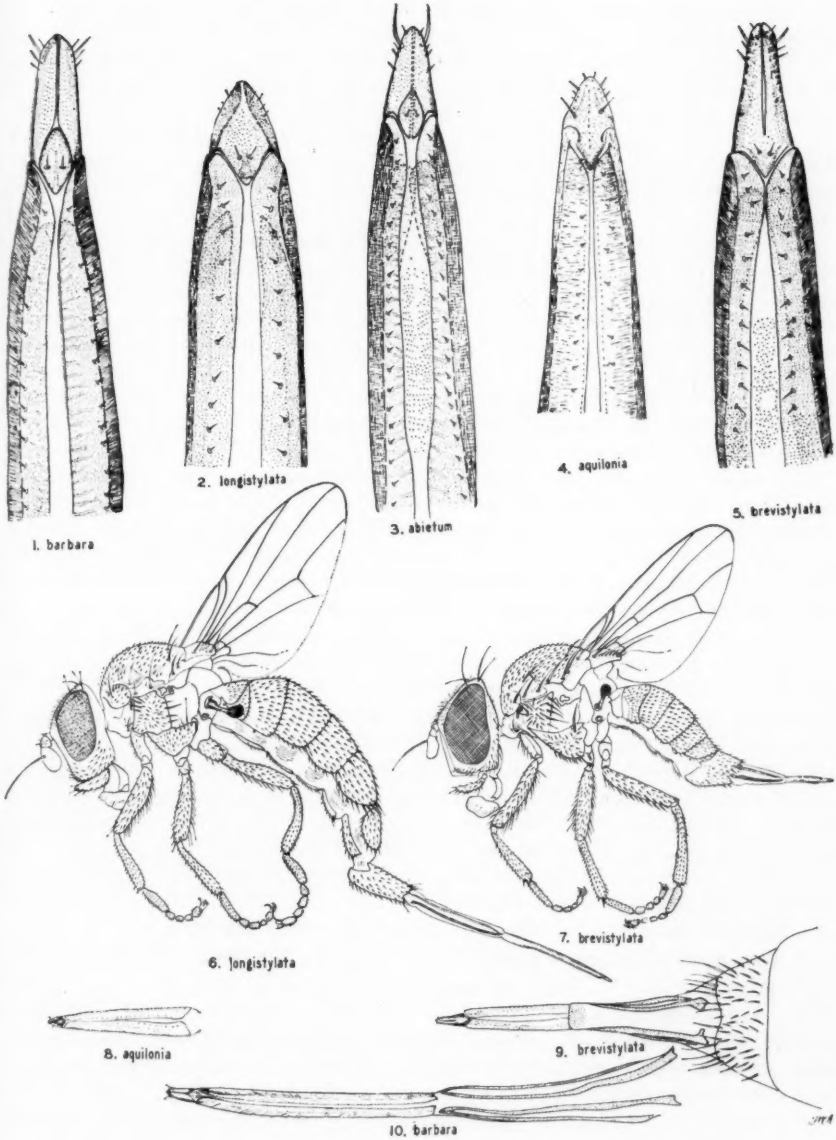
Figs. 3, 18, 20

E. abietum (genitive plural of *abies*, fir tree) has yellow tarsi, dark calyptral fringes, a cluster of stigmatal bristles, and a hairy sternopleuron. It can be separated from most species in this group by its hairy eyes and its wide cheeks. It has been reared from cones of four western species of *Abies* Mill.: *A. amabilis* (Dougl.) Forb., *A. concolor* (Gord. & Glend.) Hooper, *A. grandis* (Dougl.) Lindl., and *A. magnifica* A. Murr.

Male.—Frons dull brownish-black; about three-fourths as wide as long (3.0: 3.75)[3]; thickly haired with long, curved, setaceous hairs; these hairs subequal in length and strength to the outer vertical bristle; the inferior orbital row consisting of about 30 hairs, five or six originating above the orbital bristle. Parafacial, opposite the base of the antenna, somewhat wider than the distance between the posterior ocelli; becoming narrower below; entirely lightly cinereous pollinose. Gena (cheek) in side view about as wide as the length of the third antennal segment; bristly hairy; the oral setulae forming a scattered, dorsolaterally directed cluster, these setaceous hairs becoming weaker above; in the holotype, the oral setulae continuing dorsad along the facial ridges to a point slightly above the apex of the antenna (the oral setulae do not extend so far dorsad in all specimens). Face with a rather broad, membraneous-appearing central stripe continuing ventrad from the lunule; entirely lightly cinereous pollinose. Compound eye distinctly hairy with two to three ommatidia between any two hairs; the longest hairs almost as long as the distance between the posterior ocelli (the pubescence of the compound eyes is sometime shorter and sparser than in the type series; this is particularly true of specimens from Long's Ranch, near Ashland, Oregon). First and second antennal segments and inside of base of the third orange-brown; first segment with a row of hairs along the dorsal margin; third segment barely longer than wide (1.2:1.1); arista more than three times as long as third antennal segment (4.2:1.2), thickened on the basal one-fourth, light brownish on the basal half; pubescence of arista very short. Postocular fringe of hairs extremely short throughout; the individual hairs shorter than the eye pubescence (sometimes there are one or two longer hairs in this series adjacent to the outer vertical bristle).

Thorax and abdomen, except in anterodorsal view, shining black with faint blue-black reflections; in anterodorsal view appearing dull greasy shiny under a thin coat of brownish pollen. Mesonotum densely hairy with fine, erect hairs; these hairs at least as long as the third antennal segment; the principal bristles longer and stronger but not easily separable from the hairs. Scutellum with numerous, long, erect hairs in addition to the four scutellar bristles; the disc mainly bare, but the lateral and apical setulae (about ten and eight respectively) scattered and extending dorsomesad from the margins proper; no hairs cephalad of the lateral scutellar setae. Notopleuron with one or two hairs between the two notopleural bristles. Epimeron with a cluster of (stigmatal) bristles (four in the holotype). Mesopleuron and sternopleuron densely bristly hairy on the disc, the usual strong bristles hardly distinguishable; several weak hairs behind the strong sternopleural bristle.

[3]The numbers in parentheses that follow approximate length: width ratios throughout this paper are actual measurements (all to the same scale) and made by means of a squared ocular grid in a Bausch and Lomb stereoscopic microscope using 15X ocular and a 7.5 objective. The factor to convert these figures to millimeters is .13.



Figs. 1-10. *Earomyia* spp. 1-5, dorsal aspect of apical portion of ovipositor, 1, *barbara* (paratype, Ashland, Oreg.); 2, *longistylata* (Hopkins U.S. No. 13281a, Medicine Lake, Calif.); 3, *abietum* (paratype, Cowichan Lake, B.C.); 4, *aquilonia* (paratype, Lake Louise, Alta.); 5, *brevistylata* (Hopkins U.S. No. 12564e, McKinney Creek, Calif.). 6, left lateral aspect of female of *longistylata* (same data as 2). 7, left lateral aspect of *brevistylata* (same data as 5). 8-10, relative lengths of ovipositors of *aquilonia* (same data as 4), *brevistylata* (same data as 5), and *barbara* (same data as 1), respectively.

First two segments of each tarsus orange-yellow; the three apical segments progressively darker brownish but not black; hind metatarsus swollen in the middle. Tibiae blackish; without preapical dorsal bristles; mid tibia with a strong apical ventral bristle; this bristle as long as the width of the tibia and lying appressed to the ventral surface of the mid metatarsus. Femora blackish; posterior surface of front femur thickly set with setaceous hairs; mid femur with both antero- and posteroventral series of long setaceous hairs, the posteroventral series stronger; hind femur almost bare posteriorly, with a series of short anteroventral hairs.

Wings cloudy, yellowish hyaline; slightly paler behind; veins brownish-yellow. Calyptrae greyish-brown with dark-brown borders and fringes.

Abdomen broadly oval with a bluntly pointed apex, i.e., strawberry-shaped; black; rather shiny, particularly at the apex and along the sides, the pollen not evident here even in anterodorsal view; brownish pollinose on the disc anteriorly; last apparent segment about 1⅓ times as long as the preceding one. An upcurved pencil of fine hairs projecting posteriorly from the hindmost margins of the epandrium; these hairs barely visible in lateral aspect immediately below the apical portion of the last apparent segment.

Genitalia (Figs. 18, 20).—The "toe" of the boot-shaped epandrium relatively short; setulae shorter and more sparsely placed than in the closely related species *brevistylata* and *barbara*. The shoulder-like mesal expansion of each anterior gonopophysis with two (occasionally three) tiny setulae; this character remarkably constant in spite of its apparent insignificance, and very reliable for separating males of *abietum* from males of *brevistylata* or *barbara*.

Female.—Less pollinose, hence more strongly shining, and generally shorter-haired than the male; the principal thoracic bristles easily distinguished among the hairs; otherwise differing from the male as follows:—

Frons slightly wider than long (4.1:4.0); much shorter-haired. Parafacial broader. Hairs of compound eye somewhat shorter and sparser. Third antennal segment a little longer than wide (1.5:1.4); hairs of thorax shorter; hairs (several) on the notopleuron confined to the area anterodorsad of the posterior notopleural bristle. Mesopleuron with six outstanding bristles in the posterior mesopleural series; three or four of the anterodorsal hairs of the mesopleuron stronger than the others. Sternopleuron with only one strong bristle, with several setulae behind it and one slightly anterodorsad of it.

Preapical dorsal bristle of the mid tibia evident but very weak.

Abdomen rather highly polished, with more distinct bluish reflections.

Ovipositor (Fig. 3) about as long, as and somewhat difficult to distinguish from, that of *brevistylata*. In *abietum* the apical segment of the ovipositor shorter, with convex lateral margins whereas in *brevistylata* this structure longer with concave lateral margins (the difference between the shape of the subapical setulae of the two species not always so distinct as shown in Figs. 3 and 5).

Holotype.— ♂, Cowichan Lake, Vancouver Is., B.C., 27.I.1943, M. L. Prebble, Exp. No. 407C, reared ex *Abies grandis* cone.

Allotype.— ♀, same data as for holotype.

Paratypes.—3 ♂, 5 ♀, same data as for holotype, and 3 ♂, same data except date is 25.I.1943; 3 ♂, 6 ♀, Vancouver, B.C., W. G. Mathers, No. 17577, Lot 1, *Abies grandis* cones, 25-30.III.1935; 4 ♂, 6 ♀, Vancouver, B.C., W. G. Mathers, No. 17577, Lot 2, *Abies grandis* cones, 8-9, 11-16.IV.1935.

Holotype, allotype, and 24 paratypes in the Canadian National Collection (type No. 6414); two paratypes in United States National Museum and four at

the University of California—two in the Department of Entomology and Parasitology collection and two in the Division of Forest Insect Research collection.

Other Specimens Examined.—(1) Reared ex cones of *Abies amabilis* 2 ♂, 1 ♀, Forest Insect Survey No. P52.34.01, Forbidden Plateau, B.C., 5-8.V.1953, F.I.S. 1952. (2) Reared ex cones of *Abies concolor*: 1 ♂, 4 ♀, Hopkins U.S. No. 10842b, Beulah, Colo., collected by P. D. Sergent, Sept. 18, 1913, emerged Apr. 3-May 15, 1915; 30 ♂, 6 ♀, Hopkins U.S. No. 11430a, Shasta Nat. For., Calif., collected by J. M. Miller, Aug. 12, 1912, emerged Feb. 13-May 6, 1913; 3 ♂, 1 ♀, Hopkins U.S. No. 11430a, Shasta Nat. For., Calif., collected by J. M. Miller, Aug. 12, 1912, emerged Apr. 22-May 21, 1914; 34 ♂, 28 ♀, Hopkins U.S. No. 11441a, Sequoia Nat. For., Calif., collected by J. M. Miller, Oct. 1, 1912, emerged Mar. 9-May 13, 1914; 20 ♂, 23 ♀, Hopkins U.S. No. 12538j, Colestin, Oreg., collected by P. D. Sergent, Jul. 18, 1914, emerged Apr. 25-May 29, 1916; 3 ♂, 3 ♀, Hopkins U.S. No. 12560e, Ashland, Oreg., collected by P. D. Sergent and F. P. Keen, Sept. 2, 1914, emerged Apr. 25-June 11, 1916; 2 ♂, 1 ♀, Hopkins U.S. No. 12564e, McKinney Creek, Calif., collected by J. E. Patterson, Sept. 3, 1914, emerged Apr. 10-May 31, 1916; 1 ♀, Hopkins U.S. No. 12573e, William's Canyon, El Paso Co., Colo., collected by W. D. Edmonston and G. Hofer, Sept. 16, 1914, emerged May 4-June 3, 1916; 2 ♂, Hopkins U.S. No. 12577e, Sequoia Nat. For., Calif., collected by J. M. Miller, Sept. 24, 1913, emerged Apr. 29- May 31, 1916; 6 ♂, 22 ♀, Hopkins U.S. No. 13228d, Long's Ranch, Ashland, Oreg., collected by F. P. Keen, May 15-Sept. 3, 1915, emerged May 14-June 23, 1917; 5 ♂, 9 ♀, Hopkins U.S. No. 13290e, Kaolin Beds, Ashland, Oreg., collected by J. E. Patterson, Sept. 7, 1915, emerged May 5-June 15, 1917; 8 ♂, 6 ♀, Hopkins U.S. No. 13297d, Mineral King, Calif., collected by F. P. Keen, Sept. 11, 1915, emerged May 7-June 15, 1917; 1 ♀, Hopkins U.S. No. 13298d, Siskiyou Mts., Ashland, Oreg., collected by P. D. Sergent, Sept. 18, 1915, emerged May 5-June 20, 1917; 2 ♂, 1 ♀, Hopkins U.S. No. 14201j, Quincy, Calif., collected by F. P. Keen, Sept. 20, 1915, emerged May 5-June 20, 1917. (3) Reared ex cones of *Abies grandis*: 11 ♂, 6 ♀, Hopkins U.S. No. 132556, Wind River, Wash., collected by J. E. Patterson, Aug. 13, 1915, emerged May 5-19, 1917. (4) Reared ex cones of *Abies magnifica*: 1 ♂, Hopkins U.S. No. 13281a, Medicine Lk., Calif., collected by J. D. Riggs, Sept. 3, 1915, emerged May 5-June 15, 1917; 3 ♂, Hopkins U.S. No. 14200f, Palmerlee Ranch, Ashland, Oreg., collected by J. E. Patterson, Sept. 8, 1915, emerged May 25-June 28, 1917.

Dr. M. L. Prebble kindly provided the following additional information from his files concerning his "Exp. No. 407C" (the material reared during this experiment is included in the type series): From Aug. 19-28, 1941, squirrels dropped maggot-infested cones from large *Abies grandis* trees growing in a semi-open area at the camp-site. These cones were placed in rearing cages but failed to produce adults during the spring and summer of 1942. They were overwintered for the second time and, in response to incubation, adults emerged from Jan. 25-28, 1943.

Mr. W. G. Mathers likewise kindly provided the following notes from his files concerning the material he reared in connection with "Rearing Experiment No. 17577" (this material is also included in the type series): "Lot 1—Puparia taken Mar. 6, 1935, from a collection of *Abies grandis* cones collected in fall of 1934 at Green Timbers Forestry Station, near New Westminster, B.C. Reared in laboratory. Adults emerged Mar. 21-30, 1935. Lot 2—Puparia obtained Mar. 29, 1935, from same source as Lot I and reared in laboratory. Adults emerged Apr. 8-16, 1935."

Life History and Habits.—The rearing records for *abietum* suggests that the species usually passes two winters in the pupal stage. However, as evidenced by three specimens reared from cones of *Abies amabilis* in British Columbia, the series reared from cones of *Abies grandis* in British Columbia by W. G. Mathers and the majority of the specimens reared from *Abies concolor*, Hopkins U.S. No. 11430a, in California, it sometimes emerges after spending only one winter in the puparia.

According to the rearing records a few lonchaeids emerged from lots bearing Hopkins U.S. Nos. 12538j and 12564e after the third winter season. Specimens of *abietum* were reared from both these lots and some may have remained three years in the pupal stage.

Whether these irregularities occur in the field is not known. Rearing techniques may have adversely affected the natural train of events connected with diapause and emergence; but it is not impossible that a fraction of each generation emerges annually over a period of three years. This would ensure the continuation of the species through years that few or no cones are produced.

Earomyia aquilonia new species

Figs. 4, 8, 16, 17

E. aquilonia (*aquilus*, dark; *aquilonius*, northern, northerly) is an entirely dark species, apparently with a northwestern distribution. The following characters distinguish it from all other *Earomyia* species known to me: tarsi entirely dark brown to black, calyptrae and fringes blackish, wings brownish-fumose, eyes pubescent, several or more stigmatal bristles; disc of sternopleuron with numerous stiff hairs; body velvety-black, especially in the male. Reared from cones of alpine fir, *Abies lasiocarpa* (Hook.) Nutt., Douglas fir, *Pseudotsuga taxifolia* (Poir.) Britton, and larch, *Larix laricina* (Du Roi) K. Koch.

Male.—Frons dull brownish-black; slightly more than twice as long as wide (4.25:2.1); thickly covered with stiff setaceous hairs; these hairs almost as long as the orbital and ocellar bristles, i.e., as long as the length of the third antennal segment; about 17 inferior orbital setulae, none arising dorsad of the orbital bristle, but, in side view, the apical portion of some hairs visible above this bristle. Parafacial, opposite the base of the antenna, at least as wide as the ocellar triangle; becoming less than one-half this width below; entirely dull brownish-grey pollinose. Subgena (cheek) rather narrow, in side view not as wide (high) as the width of the third antennal segment; bristly hairy; the oral setulae, although arising in a uniserial row, giving the impression in side view of an upwardly directed cluster. Face, lunule, and genal areas brownish-grey pollinose. Compound eye uniformly but rather sparsely pubescent with three to four ommatidia between any two hairs, each fine hair slightly longer than the diameter of an ocellus. Antenna entirely black; third segment about as long as wide (1.5:1.5); arista short, about 2.5 times as long as third antennal segment; very shortly pubescent; thickened on the basal one-third; penultimate aristal segment about twice as long as wide. Postocular fringe of hairs uniformly short, those adjacent to the outer vertical bristle not twice as long as the others in the series.

Mesonotum and scutellum brownish-black, plainly dulled by a uniformly heavy coating of velvet-like, brownish pollen. Mesonotum covered with long erect hairs, the usual bristles being scarcely distinguishable among them; several hairs behind the prescutellar dorsocentrals. Scutellum with five or six hairs on the margin between the lateral and apical scutellar bristles, and about the same number between the apical bristles; these hairs not on the disc of the scutellum except at its extreme apex; one hair cephalad of the right lateral scutellar bristle,

Figs. 11-15. *Earomyia* spp. 11, ovipositor of *longistylata*, at same magnification as Figs. 8-10 (Hopkins U.S. No. 13281a, Medicine Lake, Calif.); 12, 15, ventral and right lateral aspects, respectively, of male genitalia of *longistylata* (paratype, Medicine Lake, Calif.); 13, 14, right lateral and ventral aspects, respectively, of *barbara*, (paratype, Radium, B.C.). (Note: aedeagus not shown in Figs. 12, 14).

in the type specimen, but usually this area bare. Notopleuron with one or two hairs in addition to the two notopleural bristles. Epimeron with a cluster of (stigmatal) bristles. (Five to six in the holotype). Mesopleuron and sternopleuron densely bristly hairy on the discs; the usual strong bristles scarcely distinguishable; sternopleuron with several hairs behind the strong sternopleural bristle.

Legs and tarsi brownish-black; front and hind metatarsi lighter brownish from the side; preapical dorsal tibial bristles weakly developed; mid tibia with an apical ventral thorn about as long as the tibia is wide; front femur bristly posteriorly, mid femur with a ciliate row of posteroventral bristles; hind femur without outstanding hairs or bristles.

Wings distinctly brownish-fumose, more intensely so anteriorly and basad. Calyptrae greyish-brown with darker brown borders and fringes.

Abdomen broad, the dorsum broadly oval in outline; uniformly dulled by brownish pollen as on the thorax; last apparent segment but little longer than the preceding one.

Genitalia (Figs. 16 and 17).—The epandrium, in lateral view (Fig. 17), less distinctly boot-shaped than in *abietum*, *barbara* and *brevistylata*. The "toe" relatively undeveloped, and the setaceous hairs arising from it shorter and less developed than in these three species; always with two setulae on the inner expansion of each anterior gonopophysis (Fig. 16).

Female.—In general, less pollinose and more shining than the male, particularly on the abdomen; hairs of the frons mesonotum and pleurae shorter, hence, the principal bristles easily distinguished.

Frons more than three-fourths as wide as long (3.75:4.5). Parafacial much broader, i.e., about twice as broad as in the male. (This does not mean that the parafacial is twice as wide as the female ocellar triangle.) Notopleuron without hairs. Mesopleuron with four or five strong posterior mesopleural bristles. Sternopleuron with one strong and one weaker sternopleural bristle in addition to numerous hairs, one or two of these arising behind the posterior bristle.

Dorsum of abdomen mostly shining black, lightly dusted anteriorly in the middle. Ovipositor (Figs. 4 and 8) short as in *brevistylata*.

Holotype.— ♂, Mt. Revelstoke Nat'l Pk., B.C., Eva Lk. trail, 6000', 7.VI.1952, G. P. Holland.

Allotype.— ♀, Mt. Revelstoke, B.C. 16.VII.1952, 6000', G. J. Spencer.

Paratypes.— ♀, Hedley, B.C., 19.VII.1923; 5 ♂, 4 ♀, reared ex cones alpine fir, Lake Louise, Alta., Forest Insect Service, 1951, data as follows: ♂, 3090A, 28.XII.1951; ♀, 3090A, 7.I.1952; ♀, A3090B, 10.I.1952; ♂, 3097, 2.I.1952; ♂, 3102, 8.I.1952; ♀, 3103, 8.I.1952; ♀, A3129A, 10.I.1952; ♂, A3151A, 28.XII.1951; ♀, A3151A, 10.I.1952; ♀, reared ex douglas fir cone, Radium, B.C., Forest Insect Service, 1951, A3432, 15.I.1952; ♀, reared ex larch cone, Smith, Alta., Forest Insect Service, 1949, A728, 13.VII.1949.

Holotype, allotype and all paratypes in the Canadian National Collection (type No. 6415).

Life History and Habits.—Mr. R. W. Reid, Forest Zoology Laboratory, Calgary, Alta., obtained the only reared specimens of this species known to me. He provided the following information (*in litt.*): "All specimens, reared, were collected in the larval stage in infested cones; those from alpine fir were taken Aug. 18-19, 1951, those from douglas fir on Aug. 25, 1951 and that from larch Aug. 13, 1949. With the exception of the larch cones, all were incubated from Dec. 1951 to early 1952 and emergence of adults occurred from Dec. 28, 1951

to Jan. 15, 1952. The specimen reared from larch cones emerged May 31, 1950. The cones in this case were left at a field station through the winter where they were subjected to severe cold (-30° to -40°F.). Although the time of emergence under natural conditions cannot be interpolated definitely, it seems rather certain that the species has a one year life cycle.

"Frequently four or five larvae were found burrowing throughout the cone, feeding on cone tissue and seeds. When removed from the cone and placed on a flat plane, they often curled up, locking the anterior and posterior segments together. Release was sudden, and spring-like, moving the larva one or two inches."

Earomyia barbara new species

Figs. 1, 10, 13, 14

E. barbara has the following combination of characters: tarsi yellowish, calyptrae dark, eyes bare, one to several stigmatal bristles, sternoplueron haired on the disc, and notopleuron bare except for the usual two bristles. It is the smallest species discussed in this paper and, in the larval stage, the most general (apparently not the most abundant) pest of cones. It has been reared from cones of the following species: *Abies magnifica* A. Murr., *Abies concolor* (Gordon and Glend.) Hooper, *Picea engelmanni* Parry, *Picea glauca* (Moench) Voss, *Pinus ponderosa* Laws, *Pseudotsuga taxifolia* (Poir.) Britton, and *Tsuga mertensiana* (Bong.) Carr.

Male.—Very similar to *E. brevistylata* with the following exceptions: in general a smaller, shorter and more sparsely haired species with lighter yellowish-hyaline wings. Front more than 1¼ times as long as wide (3.5:2.75). Setulae of the frons in two easily separable series, i.e., about 23 inferior orbital setulae in a uniserial row, and the other setulae of the frontal vitta irregularly aligned in longitudinal rows on the middle of the frons; no frontal hairs above the orbital bristle in the holotype; (this is the usual condition but it is not entirely constant; often there is one or two hairs above this bristle, sometimes only on the one side); in side view, the frontal hairs much shorter and sparser than in *brevistylata.* Third antennal segment distinctly longer than wide (1.45:1.3). Gena (cheek) somewhat wider (higher) than in *brevistylata* but not as wide as in *abietum.* Thorax generally more sparsely and shorter haired, the hairs somewhat more reclinate. Scutellum with fewer marginal and apical setulae; holotype with three marginal setulae on each side, and five apical setulae in addition to the usual four scutellar bristles. (The number of marginal setulae varies from one to five, but usually there are only two or three; also the number of apical setulae varies, but usually there are only two). Notopleuron bare except for the two notopleural bristles. Only one epimeral (stigmatal) bristle present (This is the usual number but often there are two and sometimes three stigmatal hairs). Mesopleuron with four outstanding anterodorsal and four strong posterior mesopleural bristles. Sternopleuron with the usual strong sternopleural bristle posteriorly and another rather strongly developed one cephalad of it; no setulae behind the strong posterior bristle.

Anterior femur with a regular row of posteroventral bristles. Mid tibia with the following bristles at or near the apex; one short preapical dorsal (less than one-half as long as the greatest diameter of the tibia at the base of the seta), one posterodorsal, two anteroventrals, two posteroventrals, and one strong ventral bristle (somewhat longer than the greatest diameter of the tibia).

Calyptrae greyish-white with brown borders and fringes. Wings pale yellowish-hyaline.

Abdomen shinier than in *brevistylata;* last apparent tergum with numerous, long, backwardly and downwardly curving hairs which, on the dorsum, decrease in length and strength from the anterior to the posterior margin. The hindmost margins of the epandria with an upcurved pencil of fine hairs projecting posteriorly; these hairs usually easily seen, in lateral aspect, immediately below the apical portion of the last apparent segment.

Genitalia (Figs. 13 and 14).—The upcurved hairs from the tip of the toe-like expansion of the epandrium longer than in related species; usually easily seen in dried specimens. Likewise, the "toe" itself longer than in related species. The expansion on the mesal aspect of each anterior gonopophysis bearing only one setula (Fig. 14).

Female.—As in the male except for the usual sexual differences. Frons slightly longer than wide (3.50:3.25); no hairs on the frons arising above the orbital bristle in allotype. (This is not true of all specimens). Third antennal segment little longer than wide (1.5:1.4); antennae wholly black in allotype but often the first and second segments and inside of base of the third tinged with brownish-orange. Epimeron of allotype with two stigmatal setulae on one side and only one on the other side. Mesopleuron with four stronger anterodorsal and posterior mesopleural bristles. Sternopleuron with one strong sternopleural bristle posteriorly and two progressively weaker ones anterior to it. Scutellum of allotype with four lateral setulae on one side and two on the other, and two apical setulae, these in addition to the usual bristles. Abdomen mostly glossy-black; very lightly cinereous-pollinose on the disc anteriorly.

Ovipositor (Figs. 1, 10) considerably longer than that of *abietum, aquilonia,* and *brevistylata,* but not nearly so long as that of *longistylata* (Figs. 10, 8, 9, 11).

Holotype.—♂, Radium, B.C., collected Aug. 25, 1951, R. W. Reid, Forest Insect Service, exp. No. 3356, emerged Jan. 9, 1952, reared from Douglas fir cone.

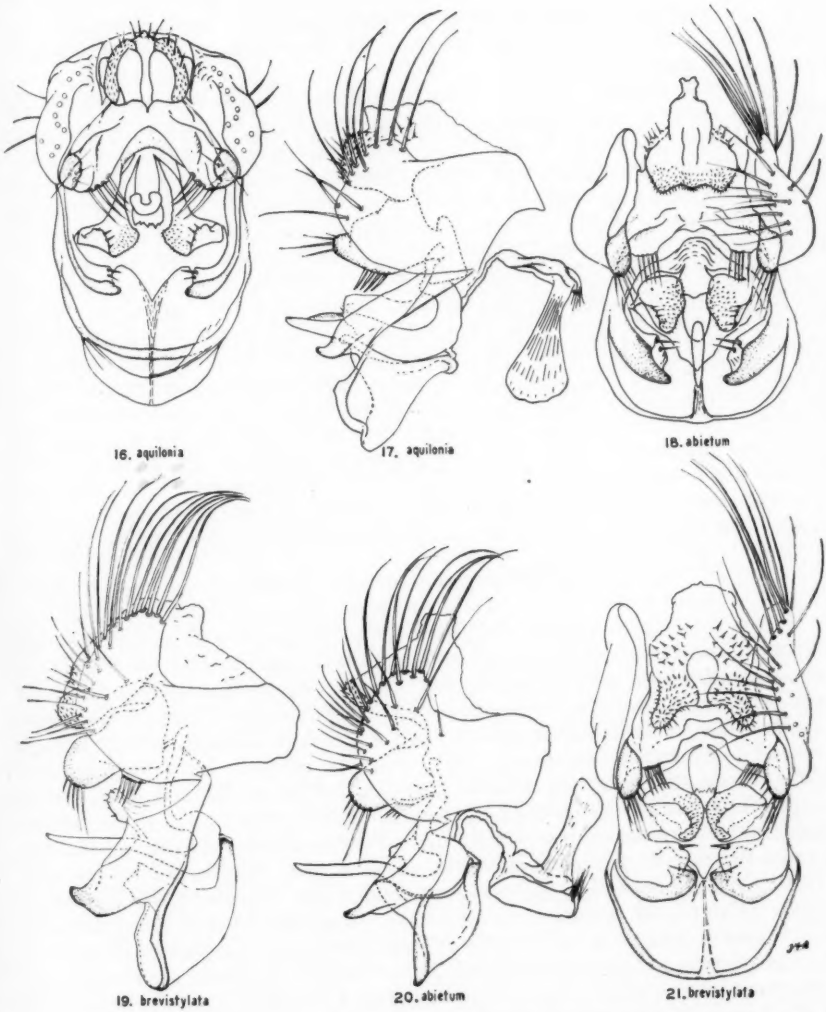
Allotype.—♀, Burmis, Alta., R. W. Reid, Forest Insect Service, exp. No. A2206, collected ?, 1951, emerged July 3, 1952; reared from Douglas fir cone.

Paratypes.—♂, ♀, same data as holotype, except dates of emergence are Jan. 14 and 18, respectively; ♂, 2♀, Burmis, Alta., R. W. Reid, Forest Insect Service, exp. No. A3189, collected Aug. 18, 1951, emerged Jan. 4 and 14, respectively; ♂, ♀, Chilcotin, B.C., June 20, 1920, E. R. Buckell, ♂ det. *Lonchaea nigrociliata* Mall. (by) C. H. Curran, ♀, bearing label "nr. nigrociliata" (G. E. Shewell); 1♂, Robson, B.C., June 1, 1949, H. R. Foxlee; 2♂, 3♀, Hopkins U.S. No. 13265k, Ashland, Oreg., collected Aug. 20, 1915, J. E. Patterson, emerged June 15, 1916; 1♀, Hopkins U.S. No. 13265j, Long's Ranch, Ashland, Oreg., collected Aug. 20, 1915, J. E. Patterson, emerged June 5, 1916.

Holotype, allotype and 11 paratypes in the Canadian National Collection (type No. 6416); two paratypes in the United States National Museum and two at the University of California—one in the Department of Entomology and Parasitology collection and one in the Division of Forest Insect Research collection.

Other Specimens Examined.—(1) Reared ex cones of *Abies concolor*; 1♂, Hopkins U.S. No. 10842b, Beulah, Colo., collected by P. D. Sergent, Sept. 18, 1913, emerged Apr. 3-May 15, 1915; 1♀, Hopkins U.S. No. 11441a, Huckleberry Meadow, Sequoia Nat. For., Calif., collected by J. M. Miller, Oct. 1, 1912, emerged Mar. 9-May 13, 1914; (this specimen bears two labels "Oct. 1, 1912, Feb. 18, 1913") 4♂, 4♀, Hopkins U.S. No. 12577e, Sequoia Nat. For., Calif., collected by J. M. Miller, Sept. 24, 1914, emerged Apr. 29-May 29, 1916; 1♂, Hopkins U.S. No. 13290e, Kaolin Beds, Ashland, Oreg., collected by J. E. Patterson, Sept. 7, 1915, emerged May 5-June 15, 1917; 1♂, 2♀, Hopkins U.S.

No. 13297d, Mineral King, Calif., collected by F. P. Keen, Sept. 11, 1915, emerged May 7-June 15, 1917. (2) Reared ex cones of *Abies magnifica*: 2 ♀, Hopkins U.S. No. 12572a, Mt. Hoffman, Yosemite Nat. For., Calif., collected by J. M. Miller, Sept. 14, 1913, emerged Apr. 20, 1915 and May 12-18, 1916; 2 ♂, 5 ♀, Hopkins U.S. No. 13281a, Medicine Lake, Calif., collected by J. D. Riggs, Sept. 3, 1915, emerged Apr. 20-June 5, 1916 and May 5-June 15, 1917; 3 ♂, 20 ♀, Hopkins U.S. No. 14200f, Palmerlee Ranch, Ashland, Oreg., collected by J. E.



Figs. 16-21. *Earomyia* spp. 16, 17, ventral and right lateral aspects, respectively, of male genitalia of *aquilonia* (paratype, Lake Louise, Alta.); 18, 20, ventral and right lateral aspects, respectively, of male genitalia of *abietum* (paratype, Cowichan Lake, B.C.); 19, 21, right lateral and ventral aspects, respectively, of male genitalia of *brevistylata* (paratype, Buelah, Colo.). (Note: aedeagus not shown in Figs. 16, 21).

Patterson, Sept. 8, 1915, emerged Apr. 10-May 25, 1916 and May 25-June 28, 1917; 2 ♂, 4 ♀, Hopkins U.S. No. 14205e, Applegate River, Oreg., collected by J. M. Miller, Sept. 23, 1915, emerged May 4-15, 1916, and June 20, 1917. (3) Reared ex cones of *Picea engelmanni*: 1 ♀, Hopkins U.S. No. 10849k, Beulah, Colo., collected by P. D. Sergent, Sept. 18, 1913, emerged Mar. 29, 1915. (4) Reared ex cones of *Picea glauca*: 1 ♀, Lake Louise, Alta., R. W. Reid, Forest Insect Service, exp. No. 3149D, collected ?, 1951, emerged Jan. 7, 1952. (5) Reared ex cones of *Pinus ponderosa*: 3 ♂, 2 ♀, Hopkins U.S. No. 13251g, Silver Lake, Oreg., collected by P. D. Sergent, Aug. 5, 1915, emerged May 17-June 14, 1916. (6) Reared ex cones of *Tsuga mertensiana*: 3 ♂, 1 ♀, Hopkins U.S. No. 12559f, Mt. Ashland, Oreg., collected by P. D. Sergent, Aug. 29, 1914, emerged Apr. 28, 1915 and May 6, 1916.

Earomyia aterrima Malloch and *E. nigrociliata* (Malloch) may be closely related to *barbara*. The former species, described from Maine and New Hampshire, and seen from New Brunswick and Quebec, seems to be larger with from four to six stigmatal hairs (usually two or three in *barbara*). *Nigrociliata*, known only from the type female from Southwest Harbour, Maine, is described as having "third antennal segment broad, its length about twice as great as its width"; in *barbara* it is not particularly broad and is scarcely longer than wide.

Life History and Habits.—All of the type material reared from cones of Douglas fir emerged the spring following collection. This seems to indicate that on this host in British Columbia and Oregon the species completes its life cycle in one year. The same is true of specimens reared from cones of ponderosa pine (Hopkins U.S. No. 13251j) in Oregon. But, in view of the limitations of the data concerning Hopkins U.S. material from cones of *Abies concolor*, *A. magnifica*, *Picea engelmanni* and *Tsuga mertensiana*, and because a number of species are involved in each of these experiments, nothing very definite can be deduced about the length of the life cycle of these specimens. However, since some specimens in these lots emerged over a period of three years, the possibility remains that sometimes *barbara* may spend more than one winter in the puparia.

Earomyia brevistylata new species

Figs. 5, 7, 9, 19, 21

E. brevistylata has yellow tarsi, dark calyptral fringes and several stigmatal bristles. Characters that distinguish it from other similar species are: bare eyes, narrow cheeks, and hairy sternopleuron. It has been reared mainly from the cones of *Abies concolor* and, in limited numbers, from cones of *Abies magnifica*.

Male.—Frons dull brownish-black, little more than one-half as wide as high (2.66:4.5); somewhat less densely hairy than in *abietum* but otherwise very similar to that species in this respect. Inferior orbital setulae, about 40, not in a uniserial row; four setulae above the orbital bristle in side view. (This number varies from two to six in other specimens). Parafacial narrower than in *abietum*; opposite the base of the arista, distinctly narrower than the distance between the posterior ocelli; cinereous pollinose, the pollen less evident along the mesal margin. Compound eye much higher than in *abietum*; hence the genal area (cheek) much narrower, i.e., hardly as wide (high) as the width of the front tibia; genal hairs and oral setulae much as in *abietum*, except the oral setulae not continuing so far dorsad on the facial ridges. Compound eye ostensibly bare. (Very sparse, minute hairs are visible under high magnification, but these are never nearly so evident or abundant as in *abietum*). Antennae, including the arista, darker than in *abietum*; the first and second segments orange-brown; the base of the third, inside, always with some orange-brown; third antennal segment as wide as long (1.5:1.5); antennae otherwise as in *abietum*. Arista less con-

spicuously pubescent than in *abietum*; about four times as long as third antennal segment (6.1:1.5); thickened on the basal one-sixth. Head otherwise much as in *abietum*.

Thorax as in *abietum* except as follows: possibly a little less shining; hairs of the mesonotum somewhat finer and shorter, hence the principal bristles somewhat easier to distinguish.

Legs the same as in *abietum*; the second tarsal segments as well as the apical three darkened particularly in the front tarsi; the hind metatarsi not so swollen as in *abietum*.

Calyptrae as in *abietum*, wings more brownish-hyaline, not so milky-yellowish, as in *abietum*.

Abdomen more pollinose laterally and apically than in *abietum*; otherwise the abdomens very similar in both species.

Genitalia (Figs. 19 and 21).—The epandrium similar to that of *barbara* and *abietum*; the ventral margin of each side rounded as in *abietum* (Fig. 20); the "toe" more elongate as in *barbara* (Fig. 13); with slight but fairly constant differences in the shape of the surstyli as shown in these lateral views. Always with only one setula on the mesal expansion of each anterior gonopophysis.

Female (Fig. 7).—Sexual differences as in *abietum* except as follows: frons slightly longer than wide (4.3:4.0); eyes bare; third antennal segment distinctly longer than wide (1.75:1.4); hairs of notopleuron more widely distributed; mesopleuron with five posterior and three anterior bristles.

Ovipositor (Figs. 5, 9) short as in *abietum*; under high magnification the lateral margins (dorsal aspect) appearing diagonally striate as shown in Figure 5. For a discussion of differences between the ovipositors of *brevistylata* and *abietum* see under the latter species.

Holotype.—♂, Whittaker Forest, Tulare Co., Calif., X.5.1948; ex larva in cone of *Abies concolor*, lot No. 186-1, K. E. Frick collector.

Allotype.—♀, same data as holotype.

Paratypes.—♂, same data as holotype with an additional label as follows: emerged Apr. 4, 1949; 8 ♂, 7 ♀, same data as holotype; 15 ♂, 15 ♀, Hopkins U.S. No. 12577e, Sequoia Nat. For., Calif., reared ex cones *Abies concolor*, collected Sept. 24, 1914, J. M. Miller, emerged Apr. 29-May 31, 1916.

Holotype, allotype and 30 paratypes in the Department of Entomology and Parasitology collection and two paratypes in the Division of Forest Insect Research collection at the University of California; four paratypes in the United States National Museum and 10 paratypes in the Canadian National Collection (type No. 6417).

Other material examined.—(1) Reared ex cones of *Abies concolor*; 13 ♂, 4 ♀, Hopkins U.S. No. 10842b, Beulah, Colo., collected by P. D. Sergent, Sept. 18, 1913, emerged Apr. 3-May 15, 1915; 8 ♂, 2 ♀, Hopkins U.S. No. 11430a, Shasta Nat. For., Calif., collected by J. M. Miller, Aug. 12, 1912, emerged Feb. 13-May 6, 1913, Apr. 22-May 21, 1914; 9 ♂, 5 ♀, Hopkins U.S. No. 11441a, Huckleberry Meadows, Sequoia Nat. For., Calif., collected by J. M. Miller, Oct. 1, 1912, emerged Mar. 9-May 13, 1914; 3 ♂, 4 ♀, Hopkins U.S. No. 12538j, Colestin, Oreg., collected by P. D. Sergent, July 18, Aug. 22, 1914, emerged Apr. 20-May 25, 1915, Apr. 25-May 29, 1916; 1 ♂, 4 ♀, Hopkins U.S. No. 12560e, Long's Ranch, Ashland, Oreg., collected by F. P. Keen, P. D. Sergent, Sept. 2, 1914, emerged Apr. 16-June 8, 1915, Apr. 25-June 11, 1916; 1 ♀, Hopkins U.S. No. 12563g, N. Cheyenne Can., Colo., collected by W. D. Edmonston, Geo. Hofer, Sept. 3, 1914, emerged May 23-31, 1916; 47 ♂, 65 ♀, Hopkins U.S. No. 12564e, McKinney Cr., Calif., collected by J. E. Patterson, Sept. 3, 1914, emerged

Apr. 10-May 31, 1916, May 12-June 15, 1917; 2 ♂, 3 ♀, Hopkins U.S. No. 12573e, William's Canyon, El Paso Co., Colo., collected by W. D. Edmonston, Geo. Hofer, Sept. 16, 1914, emerged May 4-June 3, 1916; 8 ♂, 8 ♀, Hopkins U.S. No. 12577e, Sequoia Nat. For., Calif., collected by J. M. Miller, Sept. 24, 1914, emerged Apr. 29-May 31, 1916; 3 ♀, Hopkins U.S. No. 13228d, Long's Ranch, Ashland, Oreg., collected by F. P. Keen, Sept. 3, 1915, emerged May 26, 1916, May 14-June 23, 1917; 14 ♂, 13 ♀, Hopkins U.S. No. 13290e, Kaolin Beds, Ashland, Oreg., collected by J. E. Patterson, Sept. 7, 1915, emerged May 5-June 15, 1917; 3 ♂, 10 ♀, Hopkins U.S. No. 13291i, Palmerlee Ranch, Ashland, Oreg., collected by J. E. Patterson, Sept. 10, 1915, emerged June 6-20, 1917; 7 ♂, Hopkins U.S. No. 13297d, Mineral King, Calif., collected by F. P. Keen, Sept. 11, 1915, emerged May 7-June 15, 1917; 6 ♂, 26 ♀, Hopkins U.S. No. 13298d, Siskiyou Mts., near Ashland, Oreg., collected by P. D. Sergent, Sept. 18, 1915, emerged May 6-19, 1916, May 5-June 20, 1917; 2 ♀, Hopkins U.S. No. 14201i, Quincy, Calif., collected by F. P. Keen, Sept. 20, 1915, emerged May 5-June 20, 1917. (2) Reared ex cones of *Abies magnifica*: 2 ♀, Hopkins U.S. No. 14200f, Palmerlee Ranch, Ashland, Oreg., collected by P. D. Sergent, J. E. Patterson, Sept. 8, 1915, emerged Apr. 10-May 25, 1916, May 25-June 28, 1917.

Life-history and Habits.—Rearing records of *brevistylata* indicate that the species usually remains in the pupal stage for two winters. However, under laboratory conditions a few adult specimens emerged after only one winter from Hopkins U.S. lots 11430a, 12538j, 12560e, 13228d, 13298d and 14200f. Because of this and the limitations of the Hopkins rearing records there is no way of being certain that some of these specimens are not *brevistylata* adults. In one case, Hopkins U.S. lot 12564e, emergence occurred after the puparia passed three winters.

Concerning the Whittaker Forest series reared from white fir cones (from which the type was selected) the following information is extracted from a letter from Dr. K. E. Frick, Irrigation Experimental Station, Prosser, Washington.

"The *Abies concolor* cone was collected by Mr. W. Metcalfe, Extension Forester, University of California, Berkeley, California, (and) was passed on to me Oct. 5, 1948, when lonchaeid larvae began to appear. In December, 1948, I placed the jar containing the pupae, soil, and cone on a window sill. That was a record cold winter with some days not reaching 32°F. The jar was returned to the lab on March 24, 1949. On April 4, 1949, one adult emerged. During the winter of 1950 the jar was in an unheated room that got below 32°F. several times. Adults began to emerge on Apr. 12, 1950. On June 7, 1950 five remaining pupae were put in alcohol."

I recently discovered the specimen which emerged in 1949 and have included it with the type series of *brevistylata*. Three of the five puparia preserved in alcohol contain fully formed adults that appear to have been alive and normal at the time of preservation; each of the remaining two contains a pupa that appears to have been living when placed in alcohol. I have found no reliable characters for separating these five puparia from the ones from which the adults of *brevistylata* emerged, and, had the experiment been continued into the third year, it is possible that some of them would have emerged. It seems probable that each generation of the species emerges over a period of several years—the majority appearing after the second winter.

***Earomyia longistylata* new species**

Figs. 2, 6, 11, 12, 15

Longistylata is a large, hairy, anthomyid-like species with orange-yellow metatarsi, dark-brown calpytrae and fringes, hairy eyes, numerous stigmatal hairs

and elongate abdomen. It is so named because of its very long ovipositor. The preferred host seems to be the cones of California red fir (*Abies magnifica* A. Murr.); it has also been reared from cones of grand fir (*Abies grandis* (Dougl.) Lindl.) and white fir (*Abies concolor* (Gord. and Glend.)).

Male.—Frons, including the orbital and ocellar plates, opaque black; distinctly narrowed anteriorly; about 1⅔ as long as wide (2.5:1.5); thickly and long haired, the hairs and the bristles about equal in length and strength; several weaker hairs above the orbital bristle. Parafacial at the narrowest point about as wide as the distance between the posterior ocelli; subshining black through sparse pollen; appearing rippled or coarsely rugulose opposite the apex of the antenna. Genal area (cheeks) in side view distinctly broader (higher) than the length of the third antennal segment; coarsely setulose as in *brevistylata*.

Antennal fovae distinct; face rather bulging in the middle. Lunule, antennae and face entirely brownish-black. Third antennal segment not or barely longer than wide; in the holotype slightly wider than long (1.5:1.4). (It appears to have contracted somewhat in drying). Arista slightly more than twice as long as the third antennal segment; thickened on the basal one-third; penultimate aristal segment about twice as long as wide. Compound eye rather shortly and sparsely haired; the hairs about as long as the combined diameters of two to three ommatidia, dull-brownish in colour and often difficult to see except in silhouette. Postocular setulae very short, only the dorsal four or five of the series apparent in anterior view.

Thorax entirely dulled by brownish pollen; weakly shining-black with no indication of bluish reflections. Mesonotum thickly covered with long, erect, fine hairs; the bristles scarcely distinguishable; these hairs continuing caudad on the area between the scutellum and the prescutellar bristles. Scutellum with numerous erect hairs on the margins and on the apical portion of the disc; no hairs anterior to the lateral scutellar bristles. Notopleuron with a few fine hairs on the disc in addition to the two notopleural bristles. Mesopleuron thickly long-haired, the bristles practically indistinguishable. Epimeron with a cluster of 10 to 15 long, setaceous, stigmatal hairs. Sternopleuron, like the mesopleuron, thickly long haired, the sternopleural bristle rather hair-like; one or two hairs behind the sternopleural bristle.

Front and mid femur much as in *abietum* and *brevistylata*; the hairs longer and finer. Hind femur with a complete anteroventral series of longish hairs and a ventral series of somewhat longer hairs ending abruptly at about the basal one-third; hence the hind femur somewhat similar to that of males of *Hylemya brassicae* Bouché but the condition less intense here. All tibiae black; uniformly short haired. Metatarsus, of each tarsus rather obscurely brownish-orange particularly from above; in side view distinctly lighter coloured; apical four segments of each tarsus progressively darker brown to black; hind metatarsus slightly incrassated as in *abietum* and *brevisylata*.

Calyptrae dark-brownish, with darker brown margins and fringes. Wings with a distinct brownish tinge, particularly along the anterior margin and basally; veins darker brown. Distance between the apices of Sc. and R_1 about 1⅓ as long as greatest width of the costal cell (3.0:2.0).

Abdomen more elongate than in either *abietum* or *brevistylata*; form much as in *aquilonia*; entirely brownish pollinose; weakly shining as in *aquilonia*.

Genitalia (Figs. 12 and 15).—The epandrium more generalized in shape than in any species discussed here; the toe-like extension, characteristic of the other

TABLE I

Summary of host and distributional relationships of cone-infesting species of *Earomyia* in North America
(All collections were made during larval stages)

Species	*abietum*			*barbara*			*brevistylata*			*longistylata*			*aquilonia*		
Host	State or province	No. colls.	No. reared	State or province	No. colls.	No. reared	State or province	No. colls.	No. reared	State or province	No. colls.	No. reared	State or province	No. colls.	No. reared
Abies amabilis	B.C.	1	3												
Abies grandis	B.C.	2	34							Calif.	1	13			
	Wash.	1	17												
Abies concolor	Calif.	7	124	Calif.	3	12	Calif.	7	209						
	Colo.	2	6	Colo.	1	1	Colo.	3	23						
	Ore.	5	92	Ore.	1	1	Ore.	6	87	Ore.	1	9			
Abies magnifica	Calif.	1	1	Calif.	2	9				Calif.	3	78			
	Ore.	1	3	Ore.	2	29	Ore.	1	2	Ore.	2	31			
Abies lasiocarpa													Alta.	1	9
Picea engelmanni				Colo.	1	1									
Picea glauca				Alta.	1	1									
Pinus ponderosa				Ore.	1	5									
Pseudotsuga taxifolia				Alta.	1	4									
				B.C.	1	3							B.C.	1	1
				Ore.	2	6									
Tsuga mertensiana				Ore.	1	4									
Larix laricina													Alta.	1	1

four species, almost completely undeveloped. The mesal expansion of each anterior gonopophysis bears two setulae.

Female (Fig. 6).—As in the male with the following exceptions: entirely shorter haired and more shining. Frons much broader in relation to width (2.5:3.0), and not so distinctly narrowed anteriorly. Parafacials much broader; silky-shiny. Hairs of eyes somewhat denser and more easily seen.

Principal bristles of thorax easily distinguished, the hairs being much shorter and less intense. Mesopleuron with four anterodorsal and four posterior mesopleural bristles. Hind femur without longish hairs on the anteroventral and ventral surfaces. Mid tibia with a weak preapical dorsal setula. Metatarsi more distinctly yellowish-orange; second segment of each tarsus orange-brown.

Abdomen rather elongate cone-shaped in dorsal view; distinctly shining black with little evidence of pollen, even on the dorsum.

Ovipositor (Figs. 2, 11) very long; the hairs on the apical segment difficult to see except under very high magnification.

Holotype.– ♂, Hopkins U.S. No. 13291a, Medicine Lake, Calif., J. D. Riggs collected Sept. 3, 1915, emerged Apr. 10-June 5, 1916 and May 5-June 15, 1917. Reared ex cones of *Abies magnifica.*

Allotype.– ♀, same data as holotype.

Paratypes.–19 ♂, 29 ♀, same data as holotype.

Holotype, allotype, and 34 paratypes in the United States National Museum; four paratypes at the University of California–two in the Department of Entomology and Parasitology collection and two in the Division of Forest Insect Research collection and 10 in the Canadian National Collection (type No. 6418).

Other Specimens Examined.–(1) Reared ex cones of *Abies magnifica*: 1 ♂, Hopkins U.S. No. 11436, Sequoia Nat. For., Calif., collected by J. M. Miller, Sept. 30, 1912, emerged ?; 1 ♂, Hopkins U.S. No. 12572a, Mt. Hoffman, Yosemite Nat. For., Calif., collected by J. E. Patterson, Sept. 14, 1914, emerged Apr. 20, 1915 and May 12-18, 1916; 22 ♂, 4 ♀, Hopkins U.S. No. 13281a, Medicine Lake, Calif., collected by J. D. Riggs, Sept. 3, 1915, emerged Apr. 10-June 15, 1916 and May 5-June 15, 1917; 1 ♂, 1 ♀, Hopkins U.S. No. 132996, Clover Creek, Oreg., collected by J. E. Patterson, Sept. 9, 1915, emerged Apr. 14-May 19, 1916 and May 19, 1917; 16 ♂, 13 ♀, Hopkins U.S. No. 14200f, Palmerlee Ranch, Ashland, Oreg., collected by J. E. Patterson, Sept. 8, 1915, emerged Apr. 10-May 25, 1916 and May 25-June 18, 1917. (2) Reared ex cones of *Abies concolor*: 7 ♂, 2 ♀, Hopkins U.S. No. 13228e, Ashland, Oreg., collected by F. P. Keen, May 15, 1915, emerged Apr. 25-May 31, 1916 and May 25-June 6, 1917. (3) Reared ex cones of *Abies grandis*: 6 ♂, 7 ♀, Hopkins U.S. No. 12554d, Crescent City, Calif., collected by J. M. Miller, Aug. 18, 1914, emerged Apr. 8-27, 1916.

Life History and Habits.–Information from the Hopkins records indicate that *longistylata* usually completes its life cycle in one year, i.e. adults emerge each spring after passing one winter, only, in the pupal stage. It should be noted, however, that the rearing experiments from which specimens of *longistylata* were reared, yielded adults over a two year period. In spite of the fact that most of the flies which emerged the second spring can be traced to other species, some of them may be *longistylata.*

Acknowledgments

I am very grateful to Mr. C. W. Sabrosky, United States National Museum, Washington, D.C., for arranging the loan of a great deal of material from that institution, and am indebted to him for checking lists of data against the information on the Hopkins cards filed at the U.S.N.M. I wish to thank Mr. F. P. Keen, Forestry Building, Berkeley, Calif., for rendering similar services. Also, my thanks are extended to the following people for providing me with data from their personal files concerning the species treated: Dr. K. E. Frick, Irrigation Experiment Station, Prosser, Wash.; Mr. W. G. Mathers, Forest Biology Laboratory, Vernon, B.C.; Dr. M. L. Prebble, Forest Biology Division, Science Service, Ottawa; and Mr. R. W. Reid, Forest Biology Laboratory, Calgary, Alta.

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(Received April 20, 1956)

THE RUNGE PRESS LIMITED, OTTAWA
Mailed: Friday, June 8, 1956